Engineering Library

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VOL. CL.—No. 3899] LONDON: FRIDAY EVENING, OCTOBER 3, 1930 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

TO ENGINEERING CONTRACTORS.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 21st October, 1930, for :—

(1) The INSTALLATION of LOW-PRESSURE HOT WATER HEATING at the Telephone Exchange, Pinner, Middlesex.

(2) The SUPPLY and ERECTION of CONSTANT TEMPERATURE and HUMIDITY PLANT at the Ministry of Transport Experimental Station, Harmondsworth, Yiewsley, Middlesex.

Drawings, specifications, copies of the conditions and forms of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea in each case. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 5868

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—

SIXTEEN LOCOMOTIVE BOILERS.

Tenders due 24th October, 1930.

Forms of Tender available from the above at a fee of 5s., which will not be returned. 5859

UNIVERSITY OF LONDON.

Goldsmiths' College, New Cross, LONDON, S.E. 14.

A COURSE of 52 LECTURES on

ENGINEERING ECONOMICS

will be given by T. H. BURNHAM, B.Sc., B. Com., A.M.I.M.E., on MONDAYS and WEDNESDAYS, from 7.30 to 9.30 p.m., covering the Syllabus of Section C of the Examination for Associate Membership of the Institution of Mechanical Engineers, and the City and Guilds' Final Examination in Mechanical Engineers' Estimates and Specifications.

Commencing MONDAY, 13th OCTOBER, 1930, extending to WEDNESDAY, 29th APRIL, 1931.

Mondays, Part I.: GENERAL and COMMERCIAL.

Wednesdays, Part II.: INDUSTRIAL.

Fees: 10s. per Session for one evening per week.
15s. per Session for two evenings per week.

Entries will be accepted for either or both evenings

The INAUGURAL LECTURE will be given on

THURSDAY, 9TH OCTOBER, at 8 p.m., by ENG. VICE-ADMIRAL SIR GEORGE GOODWIN, K.C.B., LL.D.,

CHAIRMAN: SIR JOHN PRESTIGE.

Admission free.

For further information apply to THE WARDEN, Goldsmiths' College, New Cross, London, S.E. 14. 5811

University College of South WALES AND MONMOUTHSHIRE.

COLEG PRIFATHROFAOL DEHEUDIR CYMRU A MYNWY.

A SPECIAL CLASS in METALLOGRAPHY, suitable for persons engaged in Metallurgy, Mining, and Engineering, will be held on SATURDAY MORNINGS at the UNIVERSITY COLLEGE, NEWPORT-ROAD, CARDIFF.

The CLASS will COMMENCE on OCTOBER 11th, 1930.

Particulars may be obtained from the undersigned.

D. J. A. BROWN, Registrar.

University College, Cathays Park, Cardiff,
September 18th, 1930. 5855

Liverpool Corporation Water- WORKS.

THIRD INSTALMENT—VYRNWY SUPPLY.

HIRNANT-MORDA SECTION.

CONTRACT NO. 14.

The Water Committee of the Liverpool Corporation is prepared to receive TENDERS for the SUPPLY of about 14 MILES of 42in. BITUMEN-LINED STEEL PIPES, together with a number of SPECIALS.

Specification and drawings may be inspected at the Water Engineer's Office, 55, Dale-street, Liverpool, on and after Monday, the 6th October, 1930. Copies of the specification and form of Tender may be obtained upon payment of a deposit of Five Guineas, which will be repayable upon receipt of a bona fide Tender and return of the documents and drawings issued.

Tenders, endorsed "Tender for Third Instalment Pipes," are to be sent through the post in a sealed envelope, addressed to "The Town Clerk, Municipal Buildings, Liverpool," so as to be delivered not later than 10 a.m. on Friday, the 17th October, 1930.

The Water Committee do not bind themselves to accept the lowest or any Tender.

WALTER MOON, Town Clerk.

Municipal Buildings, Liverpool,
30th September, 1930. 5870

Port of Bristol Authority. CONSTRUCTION OF REINFORCED CONCRETE JETTY AND DOLPHINS, ROYAL EDWARD DOCK, AVONMOUTH.

The Port of Bristol Authority is prepared to receive TENDERS for the CONSTRUCTION of a REINFORCED CONCRETE JETTY, 260ft. long by 61ft. wide, and THREE REINFORCED CONCRETE DOLPHINS, each 20ft. long by 18ft. wide, in the Oil Basin of the Royal Edward Dock, Avonmouth. The contract also includes the REMOVAL and DISPOSAL of the EXCAVATED MATERIALS.

On and after Monday, the 6th day of October, 1930, a copy of the form of Tender, general conditions, specification, schedule of prices and a copy of the contract drawings, can be obtained from the undersigned on production of a receipt showing that a deposit of £5 has been paid to the Secretary of the Port of Bristol Authority, Docks Office, 19, Queen-square, Bristol. ALL CHEQUES MUST BE MADE PAYABLE TO THE PORT OF BRISTOL AUTHORITY. The deposit of £5 will be returned to bona fide tenderers after the receipt of the Tender with all the prescribed documents and drawings.

Tenders must be enclosed in a sealed envelope, endorsed "Tender for Reinforced Concrete Jetty and Dolphins, R.E. Dock, Avonmouth," addressed to the Secretary, Port of Bristol Authority, Docks Office, 19, Queen-square, Bristol, and must be delivered to him, accompanied by all the prescribed documents and drawings by 10 a.m. on Monday, the 27th day of October, 1930.

The Port of Bristol Authority does not bind itself to accept the lowest or any Tender.

THOMAS A. PEACE, Chief Engineer.

Chief Engineer's Office,
Avonmouth Dock,
4th October, 1930. 5878

The Engineer

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PUBLIC NOTICES

Borough of Leyton. TRAMCARS, &c.

The Corporation invite TENDERS for :—

(A) 50 ELECTRIC (DOUBLE-DECKED) TRAMCAR BODIES.

(B) 50 SETS of CENTRE BEARING SWING BOLSTER TRAMCAR TRUCKS.

(C) 50 SETS of ELECTRICAL EQUIPMENTS for TRAMCARS, together with the ASSEMBLY of 50 CAR BODIES complete with Trucks, Electrical Equipments and Magnetic Brakes.

(D) 50 SETS of MAGNETIC TRACK and WHEEL BRAKE EQUIPMENTS for Double-decked Bogie Tramcars.

(E) 1 ELECTRICALLY OPERATED CAR TRAVERSER.

Forms of Tender, contract and specifications may be obtained on application to the undersigned on payment of £2 (for each set of forms), which will be returned to the tenderer who has sent in a bona fide Tender by the time stipulated, and shall not have withdrawn the same.

Sealed Tenders, endorsed "Tender for Tramcar Bodies," or as the case may be, must be delivered to the undersigned not later than Twelve o'clock Noon on Friday, the 31st day of October, 1930.

The Corporation do not bind themselves to accept the lowest or any Tender.

Dated this 3rd day of October, 1930.

JNO. ATKINSON, Town Clerk.

Town Hall, Leyton, E. 10. 5866

Great Western Railway.

The Directors of this Company are prepared to receive TENDERS for the WIDENING of the MAIN LINE between Pylle Hill Junction and Portishead Junction, Bristol—about 1¼ miles in length.

Plans may be seen and specification, forms of Tender and bills of quantities obtained at the office of the Engineer at this Station, between the hours of 10.0 a.m. and 4.0 p.m., on payment of Two Guineas, which will be returned to bona fide tenderers.

Tenders addressed to the undersigned and marked outside "Tender for Pylle Hill to Portishead Junction Widening" will be received not later than 10.0 a.m. on Thursday, the 23rd October next.

The Directors do not bind themselves to accept the lowest or any Tender.

F. R. E. DAVIS, Secy.

Paddington Station, London, 30th September, 1930. 5880

PUBLIC NOTICES

South Indian Railway Com- PANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

SPARE PARTS OF LOCOMOTIVE ENGINES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked :—"Tender for Spare Parts of Locomotive Engines," with the name of the firm tendering, must be left with the undersigned not later than 12 Noon on Friday, the 17th October, 1930.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not returned, will be made of 2s. 6d. for each copy of the specification.

Copies of the drawings may be obtained at the Offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD, Managing Director.

91, Petty France,
Westminster, S.W. 1,
1st October, 1930. 5883

Administrative County of LONDON.

There is a VACANCY for a HANDICRAFT MASTER with qualifications in Metal Work at the Basnett-road (Battersea, S.) and West-hill (Putney) Metal Work Centres (half-time in each). Candidates should be fully qualified handicraft masters, but applications will be considered from suitable candidates with some teaching experience who have passed the First Examination for Teachers of Handicraft (Metal Work) conducted by the City and Guilds of London Institute.

Salary, Burnham Scale IV. for certificated teachers in the case of fully qualified handicraft masters, and in other cases £180 fixed, pending completion of qualifications.

Apply, Education Officer (E.2), County Hall, Westminster Bridge, S.E. 1 (stamped addressed foolscap envelope necessary) for form, to be returned by 15th October. Canvassing disqualifies.

MONTAGU H. COX, Clerk of the London County Council.

5863

PUBLIC NOTICES

Metropolitan Water Board. LAYING OF MAINS.

The Metropolitan Water Board invite TENDERS for the LAYING and JOINTING of the undermentioned MAINS, each of which will be let as a separate contract :—

(A) 2230 Lineal Yards of 18in. Main from Eltham Green to Well Hall-road, in the Metropolitan Borough of Woolwich ;

(B) 4910 Lineal Yards of 15in. Main from Bickley Reservoir, in the Borough of Bromley, to Kemnal Corner, in the Urban District of Foots Cray.

The drawings and contract documents may be inspected without charge at the Offices of the Board, Chief Engineer's Department (Room 201).

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities, may be obtained on and after Wednesday, 1st October, 1930, from the Chief Engineer, on production of an official receipt for the sum of £10 in respect of each contract, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes addressed to the Clerk of the Board and endorsed in the manner indicated in the instructions to tenderers issued with the contract documents, must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Monday, 20th October, 1930.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER, Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
29th September, 1930. 5867

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a YOUNG MAN with Engineering Knowledge to FORM A COMPANY to SELL MACHINERY, the factory in United States taking half the capital. An amount of £1000 will be sufficient to start same.—Address, P313, The Engineer Office. P313 A

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Address P339, The Engineer Office. P339 A

WANTED, CIVIL ENGINEER, for Oilfields in Northern Iraq.

Must be an Associate Member of the Institution of Civil Engineers or possess some equivalent qualification.

Must have had experience in General Civil Engineering Work, particularly Roads and Water Supply, and be able to take charge of constructional work.

Must be unmarried and not over 35 years of age.

Initial salary £620 per annum or more according to qualifications.

Apply by letter, stating fully qualifications, age, &c., to IRAQ PETROLEUM CO., Ltd., King William Street House, Arthur-street, London, E.C. 4. P316 A

AN OPENING will Shortly Occur where a CONSTRUCTIONAL STEEL WORK ENGINEER with experience as General Manager in this class of engineering would find an improving position. Applicants must be under 45 years of age, of good address, with exceptional references, experience and ability to deal with every side of the business.—Address in first instance and in confidence, giving fullest particulars and stating commencing salary required, 5881, The Engineer Office. 5881 A

CONTRACTOR'S ASSISTANT ENGINEER for Large Waterworks Scheme in Northern Ireland. Direct labour. Some experience of Large Works Construction required. Age 24-28. State age, experience, whether married or single, salary required. Copies only of any testimonials. Free unfurnished rooms available near works.—Address, 5874, The Engineer Office. 5874 A

COST ACCOUNTANT REQUIRED for the North of England, to organise and take charge of the work in a large factory. Salary £600 to £800 p.a., according to qualifications. Age 30 to 40.

Full particulars of previous experience.

Address, P333, The Engineer Office. P333 A

ENGINEER WANTED for Chemical Works in London. Thorough technical and practical training necessary. Must have held similar position. Write, giving full particulars of career and state salary required.
Address, 5826, The Engineer Office. 5826 A

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FOUNDRY MANAGER WANTED. Non-ferrous Alloys. Must have full experience in Gun Metal and Phosphor Bronze Casting in all forms and in Modern Methods.
Accustomed to the Management of Men for substantial output.
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Full particulars of scientific qualifications and previous industrial experience should be given.
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OUTSIDE SALES MANAGER.—An Important British Firm of Manufacturers REQUIRE the SERVICES of a GENTLEMAN as TRAVELLING SALES MANAGER, to appoint Agents, visit customers, report upon openings and the state of trade in all parts of the world. The firm is willing to make suitable arrangements as regards salary, expenses, etc., with the right man. Age about 30 to 35.
Full particulars of previous experience, knowledge of languages, etc., and whether married or single.
Address, P328, The Engineer Office. P328 A

QUALIFIED CHEMIST REQUIRED for Laboratory Work. Experience in Colloids desirable. London district. Write, giving full particulars of qualifications and state salary required.—Address, 5827, The Engineer Office. 5827 A

REINFORCED CONCRETE DESIGNER WANTED; must be proficient and have had experience with specialist firm.—Write, stating age, experience and salary required, to INDUSTRIAL CONSTRUCTIONS, Ltd., 54, Victoria-street, S.W. 1. 5884 A

REPRESENTATIVE. Already Calling Upon Engineers and allied trades in the Provinces, REQUIRED to obtain Advertisements on Commission for a well-advertised Publication with a large circulation. Replies treated in strict confidence.—Address, P336, The Engineer Office. P336 A

REPRESENTATIVE for Old-established GENERAL ENGINEERS, chiefly jobbing, but at present considering commencing repetition work. Applicant should be acquainted with the markets for both sides. State experience, remuneration, &c.—Address, 5873, The Engineer Office. 5873 A

REQUIRED FOR WEST AFRICA.—MECHANICAL ENGINEER to Take Charge Running Plant. Must be experienced Maintenance and Repair, Steam and Electrical. Age 25/35. Salary £450/£500 p.a.
Applicants to state age, qualifications and experience in detail.
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WANTED, CHIEF DRAUGHTSMAN for Mechanical Engineers to Take Charge of about Ten Men. Necessary to have had sound all-round Engineering Training with experience in Original Design; also proved ability to organise and control Drawing Office.
Experience in Mass Production of Castings is desirable. Age preferably 30 to 45 years.
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Address, 5887, The Engineer Office. 5887 A

WANTED, LOCOMOTIVE DRAUGHTSMAN. Must be accustomed to all kinds of Arrangement Drawings. State full experience, age and salary.—Address, PECKETT and SONS, Ltd., Atlas Locomotive Works, Bristol. 5869 A

WANTED, TWO DRAUGHTSMEN for Mechanical Engineering Works. Sound technical and works training essential. Full particulars training, career, age and wages required.—Address, 5886, The Engineer Office. 5886 A

DESIGNERS REQUIRED with Thorough Technical and practical experience in Bus and Coach Chassis.—Address, stating age, full details of experience and salary, 5885, The Engineer Office. 5885 A

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SITUATIONS WANTED

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MAJOR H. O. WRAITH, M.I. Mech. E., M.I.E.E., formerly of Doxfords and of Vickers, Ltd., is about to terminate engagement with Chance Brothers Lighthouse Works, and OFFERS his SERVICES in an Administrative Engineering Capacity to a sound concern.
Would consider establishing new works in England or in a tariff-walled country abroad for a British firm.
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TRANSLATIONS, TECHNICAL, into French and German and vice versa, by experienced Engineer.—Write, L. J. S., 148, Rue Edith Cavell, Uccle, Brussels, Belgium. P310 I

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Our Advisory Director, who has devoted a life-time to his subject, will be happy to advise you on any particular point you may raise. Let us get together. Send to-day for our inspiring handbook **"ENGINEERING OPPORTUNITIES," FREE,** post free, and without obligation.
The British Institute of Engineering Technology, 22, Shakespeare House. 29-31, Oxford Street. W.1. P331 I

For continuation of Small Advertisements see page 4.

THE ROYAL
METAL TRADES' PENSION AND BENEVOLENT SOCIETY

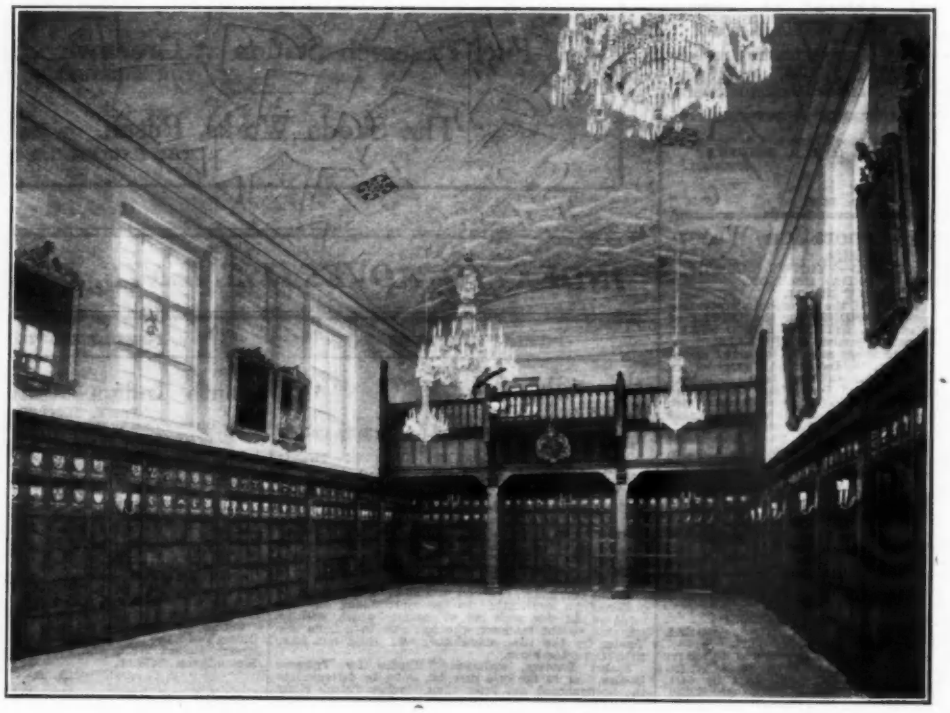
THE 82ND ANNIVERSARY

FESTIVAL DINNER

Will be held (by kind permission of the Worshipful Company of Ironmongers)

AT

Ironmongers' Hall, Shaftesbury Place, Aldersgate St., E.C.1



on TUESDAY, 25th NOVEMBER, 1930

The attendance will be limited to gentlemen.

CHAIRMAN: **Sir Gerald Chadwyck-Healey, Bt., C.B.E.**
(Chairman of Morgan Brothers (Publishers) Limited, Proprietors of The Engineer, The Ironmonger, &c.)

DINNER TICKET, EXCLUSIVE OF WINE - - 15/- EACH.

MAY BE OBTAINED FROM THE SECRETARY,
ROYAL METAL TRADES' PENSION & BENEVOLENT SOCIETY, 195, UPPER THAMES ST., LONDON, E.C.4

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A Seven-Day Journal

Wireless Telephony.

A FEW days ago members of the Council of the Institution of Electrical Engineers visited the Post Office wireless station at Rugby, where they saw the preparations that are being made to establish direct wireless telephonic communication with South America and to equip a second long-wave circuit which will provide a fifth individual channel for the service between England and the United States of America. The President of the Institution of Electrical Engineers is the Engineer-in-Chief to the General Post Office, and the tour of the station was made under his guidance. When the North American service was opened at the beginning of 1927, with one channel, it was the first international wireless telephone service designed for connection to the ordinary subscriber's system, and also the first long-distance radio telephone system brought into daily service in the world. The rapid increase in the number of calls led to the opening of an alternative short-wave channel in June, 1928, and two additional short-wave services have recently been brought into use. The cost of the short-wave directional system is less than that of the long wave, but it is said to be less reliable. A combination of the two systems has, however, enabled the Post Office to provide an effective service to America over the full 24 hours, and the position will be further strengthened when the second long-wave circuit becomes available. Extensions on either side to the telephone line and cable systems have linked practically the whole of Europe with the United States, Canada and Mexico by means of the Rugby station. It is not considered economically possible to operate long-wave telephony over greater distances than from England to America, and the solution of the problem of providing contact with the Dominions is confined to the use of short wave-lengths. An Australian service which is available for 9 hours daily was introduced five months ago, and the South American service, at present operated through Madrid, will be effected in a direct manner at an early date.

Additional Water Supply for Barry.

ON Tuesday last, September 30th, the new works, by which the Urban District of Barry is to receive additional supplies of water from Taf Fechan, were formally opened by Councillor William Gameson, the chairman of the Council. Hitherto Barry has derived its water from two wells at Biglis, whence it was pumped to two service reservoirs—at Pencoedtre and Merthyr Dyfan—which stand at elevations of 200ft. and 314ft. above Ordnance Datum respectively. The yield of the wells is, approximately, 900,000 gallons per day and the water is hard in character. Increasing difficulty in satisfying the needs of a growing population having been experienced, arrangements were made with the Taf Fechan Water Supply Board for that body to deliver water in bulk under high pressure to the Council at a point 13 miles north of Barry. To take advantage of this arrangement it was necessary to construct, at St. Lythans, a new service reservoir, to hold 3,000,000 gallons, with a top water level of 420ft. above O.D., and to connect the latter (*a*) by means of an 18in. diameter main, of steel and cast iron pipes, with the point of supply from Taf Fechan; (*b*) with a previously existing main at Weycock Cross by a cast iron and steel main varying in diameter from 22in. to 17in.; (*c*) with two pre-existing service reservoirs and with the Great Western Railway Company's reservoir at Wenvoe. The length of the main leading to the St. Lythans Reservoir is 9¼ miles, and the pipe line from the reservoir to Weycock Cross is just under 5 miles long. In view of the high pressure at the inlet main it was decided to provide a break-pressure tunnel at Soar. It was driven through Pennant rock, is 535ft. long, 6ft. high and 7ft. wide internally, and it is lined with concrete and blue bricks. It was also necessary to provide a steel lattice girder bridge, about 100ft. long, to carry the pipe line over the Great Western Railway at Crofft-y-Genau and to take the pipes in two subways under the river Ely at St. Fagans. The St. Lythans Reservoir, which is covered, measures 195ft. long by 177ft. wide by 15ft. deep. A division wall, 10ft. high, divides it into two compartments. The roof is carried on 100 brick pillars and the whole of the interior of the reservoir is lined with asphalt. The total cost of the scheme was about £165,000.

Skilled Employment and Apprenticeship Association.

SINCE its establishment in 1904 the Skilled Employment and Apprenticeship Association, of Denison House, Vauxhall Bridge-road, S.W. 1, has, through its local committees, found places in skilled trades for 21,234 boys and girls, with an average loss or wastage of only 10 per cent. The Association adopts the healthy object, not of salving the misfits, but of training and equipping the fit to become worthy, self-respecting craftsmen and craftswomen. The tastes, inclination, home conditions, recreations, social conditions, and many other aspects of each boy or girl's character are carefully inquired into by the local committee before a trade for them is selected. The advice and assistance is given free to the parents and children. The Association helps the selected boys and girls to obtain posts as apprentices or learners in the trades chosen for them. If premiums are required or expenditure on the purchase of tools is necessary, the Association advances the money on condition that it is repaid by instalments. In this connection it is satisfactory to note that the new premiums paid in 1929 by the Association amounted to £278 10s., and that the repayments by apprentices reached £294 10s. 6d. The Association has affiliated committees at Bethnal Green, Fulham, North Lambeth, and Stepney. Last year these committees dealt with 2446 cases and placed 1221 boys and girls in trades and other occupations as apprentices or learners. Of the 673 boys for whom positions were found, engineering and the heavy metal trades absorbed 165. Among the girls, the highest fraction, namely, 284 out of 548, entered the needlework trades. The Association is being encouraged by employers' and workers' organisations to extend the area of its work. Last year its total income was only £80 9s. 9d. To enable it to expand its activities it is now issuing an appeal for subscriptions to a fund which it is hoped will reach £3000.

Reclaiming the Zuider Zee.

IN our issues of August 9th and 16th last year, we gave an illustrated description of the measures which are being taken to reclaim the Zuider Zee. After nearly seven months of pumping the first of the four polders—the North-West Weiringer Meer—is now quite dry. The two pumping stations at Den Oever and Medemblik have now completed their task, and one is shut down, the other only being in use for a few hours in the week to deal with rain water. The Government has now started the making of the roads, ditches and trenches. The length of the ditches alone will exceed 500 miles. Some 500 farm-houses are to be built and labour will thus be found for the unemployed. The reclaiming of the three remaining polders is rendered easier by the advanced state of the dam enclosing the four polders, which will allow the work to proceed in calm water without interruption from the tides. The polder recovered is a little less than 10 per cent. of the area to be reclaimed, and there still remains about 515 million acres to be drained. Up to the present a sum of £15,000,000 has been spent, one-third on the polder already reclaimed and two-thirds on the enclosing dam for the polders. The soil of the recovered land is stated to be very good and the scheme is expected to be financially economic, since the cost of the work will, it is intended, be eventually recovered by the sale of the land.

The Assuan Dam.

THE tragic death of Sir John Norton-Griffiths, to which reference is made elsewhere in this issue, does not annul the contract between his firm and the Egyptian Government for the heightening of the Assuan Dam. At the moment of writing, however, it is not certain whether the company will continue the work. The Egyptian Government has intimated that it will proceed at once to take steps to secure the completion of the undertaking. It is denied, however, that the work of cutting down the structure preparatory to heightening it has seriously diminished the quantity of water which can be stored in the reservoir during the coming winter. The work required to restore the dam to its former capacity is stated to be insignificant in nature and cost. While the contractors are discussing the question of continuing the work, Sir John Jackson and Co., Ltd., have submitted an offer to the Egyptian Government for its completion. The firm has £250,000 worth of plant in Egypt available for the work and is ready to continue it at twenty-four hours' notice. It is prepared to execute the work at cost price plus terms of remuneration to be decided upon between it and the Government.

An Outstanding Motor Passenger Liner.

AN outstanding motor passenger liner of the year is the new 17,300-ton quadruple screw motor liner "Reina del Pacifico," which has been built and engined by Harland and Wolff, Ltd., at Belfast, for the West Coast South American service of the Pacific Steam Navigation Company, Ltd. She was launched last week and is now being fitted out and completed. She has a length between perpendiculars of 550ft., with a 76ft. beam and a moulded depth of 44ft. The engines are of the single-acting four-stroke type, with trunk pistons and, when pressure charged, each of the four twelve-cylinder units has a designed output of 5500 S.H.P., making a total of 22,000 S.H.P. The normal speed of the engines corresponds to a service speed of about 19 knots and is 145 r.p.m. The design and building of the engines and the design and lay-out of the auxiliary machinery has been supervised by Mr. Lee Wood, the owner's superintendent engineer, and the arrangement embodies several interesting features. Silencer boilers of the Clarkson thimble-tube type are to be fitted for both the main propelling and the auxiliary lighting sets. For the purpose of pressure charging the engines on the Büchi system, there are to be four Brown-Boveri turbo-blowers, driven by exhaust gas turbines, each of which has a designed capacity of 455 cubic metres of air per minute, delivered at a pressure of 1·33 kilos. per square centimetre. The bore of the cylinders of the main engines is 630 mm., with a stroke of 1200 mm. There are four oil-electric generator sets, comprising airless injection Harland-B & W engines, coupled to 220-volt generators. The propelling machinery has a larger output than the "Britannic," and the power developed will be the largest on any motor ship in the world excepting the Italian motor passenger liner "Augustus." It is of interest to note that the main engines are of the same type as would have been probably installed in the projected 60,000-ton White Star liner, but in that case they would have been employed to drive generators which would have supplied the current required by the electric propelling motors.

The Liverpool Oil Cake Explosion.

ON May 5th of this year an explosion occurred at the oil cake and seed-crushing mills belonging to Joseph Bibby and Co., of Liverpool, as a result of which six men were killed and eighty injured. An official statement issued by the company at the time attributed the disaster to the spontaneous combustion of oil-bearing sunflower cake stored in a steel silo. At the same mills in 1911 an explosion and fire occurred which involved the loss of thirty-six lives and injury to one hundred persons. Mr. H. J. Peacock and Mr. L. C. McNair, Inspectors of Factories, Home Office, have now issued their report on the explosion of last May. They state that while there was no doubt a dust explosion the conditions were entirely different from those obtaining in any previous explosion known to them which has occurred in this country. They trace the original cause of the explosion to the heating of the sunflower seed cake, and the consequent transference of heat through the thin steel walls to the adjoining silos. Oil cake is not, however, explosive. The actual explosion occurred in an adjoining silo containing parboiled rice bran, the dust of which was confirmed to be explosive by the Mines Department Testing Station. The bran was being slowly run out of this silo, and it is thought that a bridge of the material had formed, that this bridge collapsed, and that the dust cloud thrown up was exploded by the heat from the sunflower cake silo. An alternative explanation is advanced which is based on the possibility that a dust cloud was raised by the preliminary explosion of a small quantity of carbon monoxide formed as a result of partial combustion. The Inspectors suggest several methods for preventing similar accidents. These suggestions include the separation of silos from each other by an air space or by a heat-insulating material, and the continuation of the silos through the roof, with light covers on top to lift in case of an explosion. The possibility is considered of dealing with a fire in a silo by means of a supply of carbon dioxide or other inert gas which could be admitted through tubes fitted with fusible plugs.

An Important Coal-Oil Experiment.

A SUB-COMMITTEE of the Committee of Imperial Defence is considering the proposal that the Admiralty should use oil extracted from British coal, in place of imported fuel oil. In order to test the suitability of oil produced by low-temperature carbonisation for burning in the boilers of naval vessels without altering the oil-burning systems already in use, it has been decided by the Admiralty to place an order with each of nine low-temperature carbonisation firms for 20 tons of coal oil. The 180 tons of fuel so obtained will be employed for steaming tests at sea. We understand that the price at which the oil will be supplied to the Admiralty is a strictly competitive one compared with that of imported fuel oil. The movement in the direction of a wider use of liquid fuel produced from British coal is the direct result of negotiations which have taken place between the Department of Scientific and Industrial Research and the Low Temperature Coal Distillers' Association, Ltd., a body which was formed in July last to promote the interests of firms engaged in the low-temperature carbonisation industry. It is suggested that the whole of the oil which can be produced to Admiralty specification should be purchased by the Admiralty, the lighter fractions being made available for the Royal Air Force. A figure of 1,500,000 tons of fuel oil per annum has been mentioned as covering the possible requirements of the Navy, and when it is recalled that upwards of 40,000,000 tons of coal is mined per annum in this country for domestic purposes alone, and that from each ton of coal an average of 18 gallons of oil can be produced, there would, it appears, be no difficulty in covering the naval demands and providing, also, for mercantile and land uses, both for oil-burning furnaces and heavy-oil engines.

The Shishkoff Hydro-Thermal Tidal Power System.

No. II.*

Of the various items composing the Shishkoff hydro-thermal tidal power system, only two call for detailed description, namely, the brake or heat generator and the governing unit, which controls the flow of water through the brake in accordance with the demand on the alternator and the power developed by the water turbine.

In Fig. 5 we illustrate in section the brake, alternator and governing gear. The heat generator is the subject of a patent by Heenan and Froude, Ltd., and embodies the same power-consuming elements as the standard Froude brake which is in familiar use for measuring the outputs of prime movers of all sizes. The rotor—see Fig. 6—is formed on both sides with numerous oval pockets divided from each other by radial vanes. It is surrounded by elements of similar design—see Fig. 7—which are fixed in the casing of the heat generator. The vanes of these fixed elements are drilled with two series of holes. Through one series water is admitted into the oval pockets. The interaction between the rotor and fixed elements causes the water in the pockets to form vortices. At the centre of the vortices cavitation occurs. The cavities are occupied by steam and are connected through the second series of holes in the vanes of the fixed elements, and a run of piping, with the steam space of the Ruths accumulator. The water in the pockets escapes between the lips of the rotor and the fixed elements, and is led off by a common outlet. The amount of power consumed by the brake and changed into heat in the water varies directly with the quantity of water contained in the pockets. As the quantity of water in the pockets diminishes, the cavities containing steam at the centre of the vortices increase in size.

The heat generator shaft is protected by non-corrodible sleeves, and is surrounded by long glands—see Fig. 6—designed to prevent the escape of hot water from the system. The shaft bearings are lubricated by oil supplied under pressure by a reciprocating pump.

From the main shaft skew gearing transmits power to a horizontal cross shaft, at one end of which there is a governor and at the other the centrifugal pump, which circulates the water between the steam accumulator and the heat generator. The governor acting through an oil relay and a system of links controls a balanced piston valve, whereby the flow of water circulated by the pump through the heat generator is varied to suit the load on the electrical alternator and the output of the water turbine. Should the speed of the alternator tend to rise either because of a diminution in the demand on it for electrical energy or because of an increase in the power output of the water turbine as the tidal head becomes greater, it is the duty of the governor to bring about an increase in the flow of water through the brake. The pockets, as a consequence, are more closely packed with water, the power converted by the brake into heat is increased and the tendency of the water turbine and alternator speed to rise is checked. If the speed tends to fall, the governor effects a diminution in the flow of water to the brake, thereby decreasing the amount of water in the pockets, reducing the power converted into heat by the brake and checking the falling tendency of the speed. During our visit to the experimental plant at Avonmouth, the governor was not working quite perfectly, but with very little attention it held the speed constant at 500 r.p.m., while the tide fell from the maximum to the minimum level.

The action of the balanced piston valve operated by the governor will be followed from Fig. 8. In the minimum position, the circulating pump draws the water from the accumulator and returns it thereto without passing it through the heat generator. In this position, it will be noted the heat generator outlet is open to the pump suction. The pockets are therefore drained of water and the brake rotates in a partial vacuum and consumes no power. All the energy developed by the water turbine is therefore being transmitted to the electrical alternator.

The movement of the piston valve through $\frac{1}{4}$in. to the left preserves the conditions of the minimum position substantially unchanged. A slight additional movement, however, will open the port leading to the heat generator inlet. The heat generator outlet is still open to the pump suction. The circulating pump at this setting returns the bulk of the water straight to the accumulator. It delivers, however, a portion of its throughput to the heat generator, the water so delivered returning to the pump suction. In this way the heat generator and its pipe connections are primed.

When the balanced piston valve moves through $\frac{3}{8}$in. to the left from the minimum position, the port leading to the accumulator is completely closed. The only exit for the pump discharge is now through the port—about $\frac{1}{4}$in. open—leading to the heat generator. The whole throughput of the pump therefore passes to the heat generator. The quantity of water passed to the heat generator is, however, limited, because of the restricted opening of the inlet port to the generator. The heated water returning from the generator is delivered through the generator outlet port, and is sent back to the accumulator by the port which leads to that vessel and which is now open at its right-hand side. The second diagram in Fig. 8 shows the conditions at a slightly later stage, namely, when the valve has moved $\frac{3}{8}$in. to the left. It will be

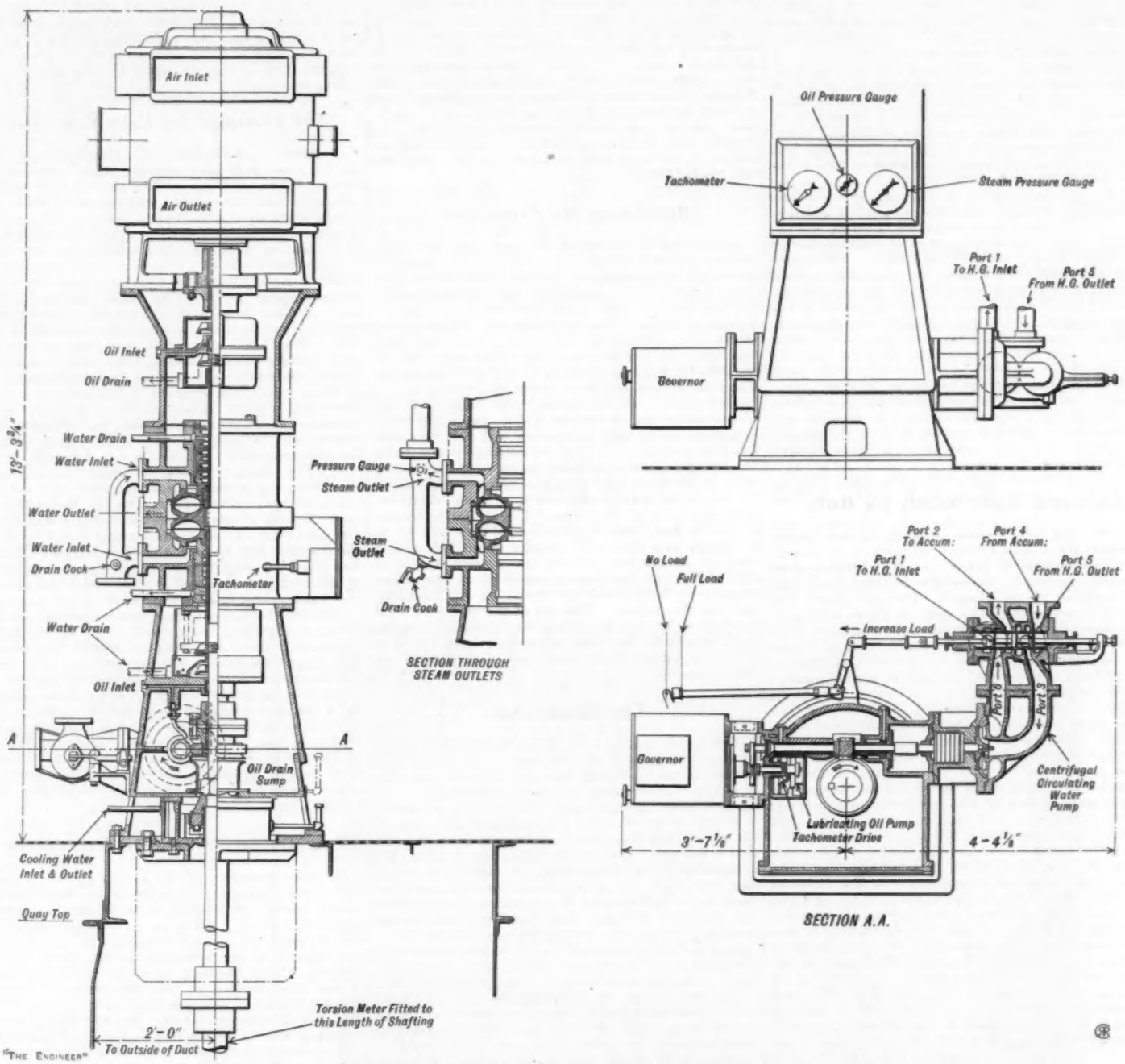

FIG. 5—GENERAL ARRANGEMENT OF HEAT GENERATOR, VERTICAL ALTERNATOR AND GOVERNING GEAR

* No. I. appeared September 26th.

noted that the pump discharge to the heat generator is still somewhat restricted, but that the hot water leaving the generator has a free passage back to the accumulator. As the valve continues to move over to the left—the maximum position is reached at a total movement of 1¼in.—the discharge of the pump to the heat generator becomes less and less restricted. Simultaneously, the area of the outlet port through which the hot water returns from the heat generator to the accumulator progressively decreases.

The tests which were conducted on the Avonmouth, plant at the end of July by Messrs. Kincaid, Waller, Manville, and Dawson, were directed towards determining the most critical factor connected with the system of working, namely, the percentage of the energy input to the heat generator which was recovered as heat in the Ruths accumulator. Extensive tests with the steam turbo-alternator were not carried out, for information of a perfectly trustworthy kind already exists concerning the efficiency of such a plant when run with a falling steam pressure as given by a steam accumulator. Further, it was realised from the outset that any test conducted on the steam turbo-alternator portion of the plant would yield no results of value for the design of a large-size installation on the Shishkoff system, because of the inefficiency in the matter of steam consumption which is characteristic of turbines of very small capacity.

The energy input to the heat generator was measured by means of a Ford-Siemens electrical torsionmeter situated on the vertical shaft between the water turbine and the heat generator. When considering the results of the tests it should be noted that the water turbine was designed to work at heads ranging from 12ft. to 36ft. The conditions at the docks made it necessary to carry the water to the turbine through a pipe line 600ft. in length and 42in. in diameter and to introduce several bends, horizontal as well as vertical, into it. In addition, the pipe line rises from the inlet in order to pass over the sea wall of the lock. It is estimated that the frictional and siphoning losses in the pipe line represent a reduction in the effective head of from 5ft. to 6ft. Moreover, a further loss of available head occurs by reason of the fact that the draught tube of the turbine has a water seal at its lower end, the level of the water in which is 6ft. or 7ft. above the lowest level to which the sea falls at the ebb of the tide. Altogether the plant under the most favourable conditions cannot work at more than about 66 per cent. of its designed capacity. It will be recognised that this deficiency is a consequence of the conditions of installation of the plant and is not in any way attributable to the system of working which it exemplifies.

The consulting engineers carried out four preliminary tests on the plant to ascertain the losses and methods of reducing them, namely, on July 28th, from 12.30 p.m. to 8 p.m.; on July 29th, from 12.45 a.m. to 9 a.m.; and from 1.5 p.m. to 8 p.m.; and on July 30th, from 1.45 p.m. to 9 p.m. They report that during the whole of these four periods no difficulty was experienced in operating the heat generator, although the tests showed that it was necessary to make certain improvements as regarded the glands, governing gear and lagging. The tests consisted of transmitting the entire output of the water turbine to the heat generator, the speed throughout being governed at 500 r.p.m., of measuring the output from the turbine, and of determining what percentage of it reappeared as heat in the accumulator. The following figures give the results of the second and third tests —

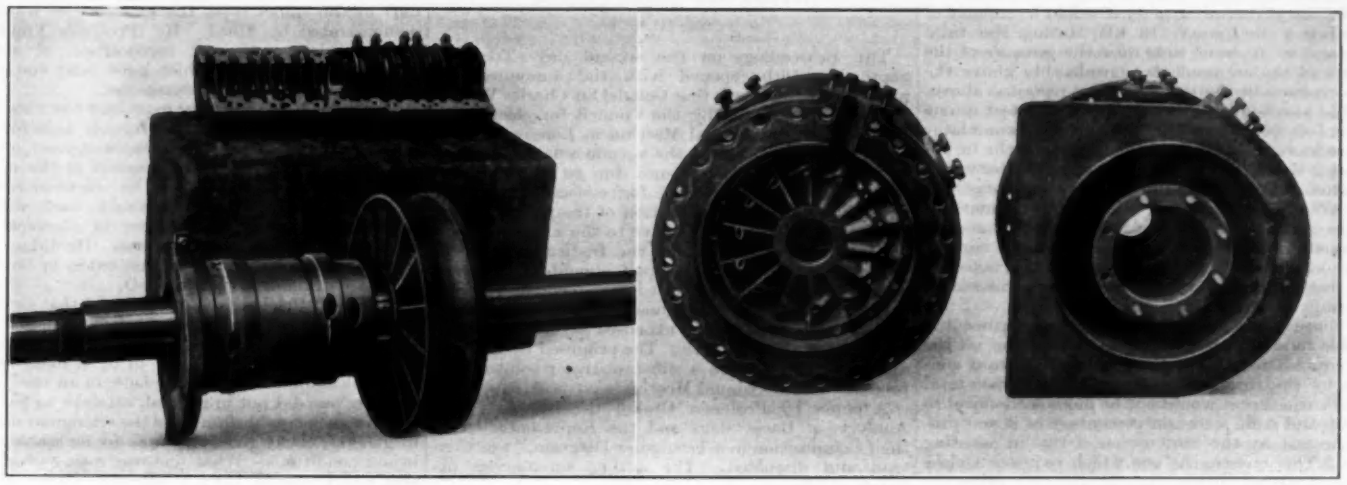

FIG. 6—ROTOR AND GLAND OF HEAT GENERATOR

FIG. 7—FIXED ELEMENTS OF HEAT GENERATOR

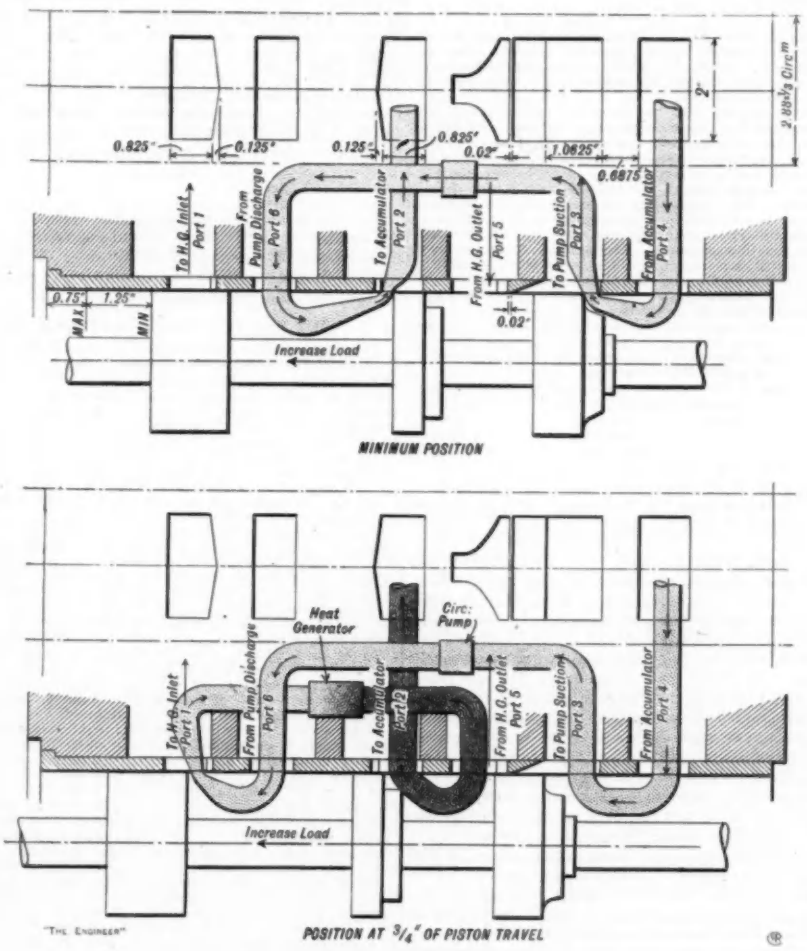

FIG. 8—ACTION OF GOVERNING VALVE

Hydro-thermal Tidal Power Scheme, Avonmouth.

	Test 2.	Test 3.
Date	July 29th, 1930	July 29th, 1930
Duration of run, hours	8·25	6·92
Input to Brake :		
Range in H.P.	38·6–234·3–19·5	27–234·3–101·5
Total input, B.H.P. hours	1,360	1,146
Thermal equivalent, B.Th.U.	3,450,000	2,910,000
Accumulator :		
Water contents at start, lb.	24,960	21,600
Water contents at finish, lb.	21,800	18,000
Leakage, lb.	3,160	3,600
Water equivalent of vessel, lb.	1,400	1,400
Water equivalent plus water contents at end of test, lb.	23,200	19,400
Gauge pressure at start, lb. per sq. in.	nil	44
Steam temperature at start, deg. Fah.	212	291·5
Gauge pressure at end, lb. per sq. in.	50	162
Steam temperature at end, deg. Fah.	298	371·6
Gain of heat by water in vessel, B.Th.U.	2,030,000	1,615,000
Gain of heat by steam in vessel, B.Th.U.	14,000	45,000
Total gain in vessel	2,044,000	1,660,000

In the following table an approximate heat balance for the two tests is given :—

Approximate Heat Balance.

	Test 2.		Test 3.	
	B.Th.U.	% input to brake.	B.Th.U.	% input to brake.
Heat gained in accumulator	2,044,000	59·3	1,660,000	57·1
Gland leakage loss	153,000	4·4	155,000	5·3
Radiation from accumulator*	156,000	4·5	179,000	6·1
Radiation from pipes and valves*	123,000	3·6	142,000	4·9
Loss in heating up brake, pipes and valves and water contents thereof*	238,000	6·9	222,000	7·6
Losses unaccounted for, including windage, friction, brake auxiliaries, &c.	736,000	21·3	552,000	19·0
Totals	3,450,000	100·0	2,910,000	100·0

* Estimated.

Two tests were carried out on the steam turbo-alternator, the steam being drawn from the accumulator following a tidal heating period. The results of these tests are given below :—

Tests on Steam Turbo-alternator.

	Test 1.	Test 2.
Date	July 29th, '30	July 30th, '30
Start	9.4 p.m.	9.35 p.m.
Stop	9.19 p.m.	10.35 p.m.
Steam pressure at start, lb./sq. in.	138	144
Steam pressure at finish, lb./sq. in.	111	48
Vacuum at start, in. Hg.	24	24·5
Vacuum at finish, in. Hg.	23	25·0
Alternator speed at start, r.p.m.	1500	1500
Alternator speed at finish, r.p.m.	1470	1500
Output of alternator at start, kW	8	30
Output of alternator at finish, kW	34	30
Average output of alternator, kW	26	30

The steam turbine is designed to run at any pres-

sure from 200 lb. down to 20 lb. It will hardly escape notice that in fifteen minutes' time the pressure in the accumulator during the first test fell 27 lb. and that during the second test it fell 96 lb. in an hour. It may perhaps be argued that such falls are inconsistent with the ability of the steam turbine plant to maintain the output of the station during the 4½ hours non-tidal period. We have already stated that the Avonmouth plant, for reasons not connected with its principle of operation, is compelled to run at about two-thirds of its designed capacity. There is little doubt that if it could be run at its full capacity it would be capable of generating a continuous 16 kW during the tidal period and at the same time raise the pressure of the contents of the accumulator considerably above the figures realised in the tests we have recorded above. It should also be observed that during the test of one hour on July 30th the fall of 96 lb. in the accumulator pressure was attendant upon the running of the turbo-alternator almost at the peak load of 32 kW for which the station is designed and not at the continuous load of 16 kW. Finally, as has already been remarked, turbines of the small size employed in the Avonmouth experimental plant are very inefficient as regards steam consumption. When allowance is made for all these facts the drop recorded in the accumulator pressure is neither startling nor disquieting.

The question arises in this connection whether it is desirable to aim at storing in an accumulator all the heat required for the production of the steam consumed by the turbo-alternator during the non-tidal period or whether it would not be more economical to generate and store a certain percentage of it and produce the rest by the combustion of fuel in assisting boilers. This question is one which requires a close analysis of capital and running costs, and it is primarily to obtain data necessary for undertaking the study of such problems as this one that the Avonmouth plant has been erected. It is perhaps sufficient for the moment if we say that Mr. Shishkoff is of the opinion that in certain circumstances the employment of fuel-fired assisting boilers would be profitable. Basing his calculations on the results achieved at Avonmouth, he estimates that a fuel-assisted tidal power plant of 9000 H.P. maximum output could be erected to produce electrical energy at a cost of 0·241d. per unit averaged over a year, namely, at 0·115d. representing capital charges, maintenance and repairs and labour for the hydro-thermal station, 0·039d. for the fuel, capital cost and labour for the assisting boiler plant, and 0·087d. the capital charges, maintenance and repair of the reservoir or barrage works. For comparison it may be said that the first Government estimate for the Severn barrage scheme gave for the cost of machinery alone a figure of 0·368d. per unit produced.

On August 27th two further tests were carried out, following steps taken to reduce the leakage losses at the glands of the brake and the losses by radiation. During these tests the output of the water turbine was in part expended in the brake and stored as steam in the accumulator, and in part was directly converted into electrical energy in the vertical alternator. The results are therefore not strictly comparable with the July test figures set out above, for, as we have said, during the earlier trials the vertical alternator was on open circuit, and the entire output of the water turbine was expended within the brake. The results of the August tests are summarised in the following table:—

Hydro-thermal Tidal Power Scheme, Avonmouth.

Date	August 27th, 1930 Test 1.	Test 2.
Duration of run, hours	8·45	8·00
Input to brake and electrical generator—		
Range in H.P.	28·5–250–15	31–238 43
Total input, B.H.P. hours	1,510	1,352
Accumulator—		
Gauge pressure at start, lb. per sq. in.	30	29
Gauge pressure at end, lb. per sq. in.	134	132
Electrical generator—		
Range of output, kW	23·5–31·5	10–32
Total electrical output, kWh	189	198
Approximate heat balance—		
Output of water turbine, B.Th.U.	3,830,000	3,430,000
Heat gained in accumulator, B.Th.U.	2,048,400	1,764,200
Electrical output, B.Th.U.	640,000	684,000
Total energy stored and converted, B.Th.U.	2,688,400	2,448,200
Percentage of turbine output stored	53·5	51·4
Do., converted	16·75	20·0
Do., stored and converted	70·25	72·4
Percentage of turbine output lost	29·75	27·6

It will be observed that a very marked increase in the percentage of the water turbine output usefully employed was registered in these tests. The earlier tests showed that 57 to 59 per cent. of the turbine output was being stored in the accumulator. The August figures show that 70 to 72 per cent. of the output was being stored or converted. The improvement is in part to be set down to the reduction effected in the gland leakage and radiation losses. It is also in part, no doubt, to be ascribed to the fact that a portion of the turbine output was being used directly in a machine—an electrical generator—of high efficiency, and was relieved of the losses associated with the storage system.

It is believed that with still further improvements to the glands and lagging, the losses will not exceed 25 per cent. when the plant is working at 75 per cent. of its designed load and 20 per cent. when it is working at full load.

The Iron and Steel Institute.

AUTUMN MEETING IN PRAGUE.

No. III.*

The proceedings on the second day—Tuesday, September 16th—opened with the announcement made by the secretary that Colonel Sir Charles Wright had been nominated by the Council for election as President at the Annual Meeting in London in May next. The next item on the agenda was the reading of the list of Vice-presidents due to retire at the Annual Meeting and eligible for re-election, and that was followed by the notification of the proposed new by-law of the Institute relative to the administration of the income and funds of the Institute, and providing that no portion thereof should become the source of pecuniary profit to any member thereof, except in the proper remuneration of paid officials or the reimbursement of expenses actually incurred on behalf of the Institute. The proposed by-law was agreed to and will be a substantitive resolution for proposal at the Annual Meeting next year.

A paper by Professor Otakar Quadrat on "The Analysis of Basic Slags and the Representation of their Composition in a Triangular Diagram," was then read and discussed. The author summarises his paper as follows:—

THE ANALYSIS OF BASIC SLAGS.

The author points out that little attention is paid in literature to an error involved in the determination of ferric oxide and sulphidic sulphur in basic open-hearth slags. The determination of sulphidic sulphur by decomposition of the slag by acid in a current of carbon dioxide, following the usual procedure adopted with an apparatus as used for the determination of sulphur in iron, absorption of the sulphuretted hydrogen in cadmium acetate, iodometric determination of the sulphur, and oxidimetric determination of the bivalent iron, produces results for the sulphur which are too low, while those for the bivalent iron are too high. The content of the trivalent iron, as represented by the difference between the total iron and the bivalent iron, is then lower than the amount actually present. The error is due to the reaction

$$2Fe''' + 8'' = 2F'' + 8,$$

which takes place when the slag is decomposed by acid, as well as to a reaction between the sulphuretted hydrogen liberated and the ferric salt. In order to obtain accurate figures for ferric oxide and sulphidic sulphur the author has worked out the following procedure:—

1. The total sulphur and the sulphate sulphur are determined gravimetrically; the difference between these two figures indicates the content of sulphidic sulphur, *a*. Then the sulphidic sulphur, *b*, is determined iodometrically, by the method mentioned above, in a separate sample of slag, and the bivalent iron contained in the solution of decomposed slag is determined oxidimetrically. For decomposing the slag a mixture of dilute sulphuric acid and hydrochloric acid is used. The difference, $a-b$, indicates the amount of sulphidic sulphur, *c*, which is lost in the iodometric determination. This amount, *c*, is equivalent to that of the trivalent iron which is reduced when the slag is decomposed. By subtracting this figure from that for the bivalent iron, as determined by titration, the accurate figure for the bivalent iron is obtained.

2. For the rapid determination of sulphidic sulphur in slag, the trivalent iron is reduced by zinc powder at an elevated temperature, and the sulphidic sulphur is determined iodometrically in the product of this reaction.

3. The results of the complete analysis of twenty-five slags are plotted in a triangular diagram, in which the components considered are as follows:—

$$A = CaO + MgO + FeO + MnO,$$
$$B = SiO_2 + P_2O_5 + 8'' + 8O_3, \text{ and}$$
$$C = Al_2O_3 + Fe_2O_3.$$

The author draws attention to an apparently labile system, $Fe_2O_3 + 8''$, existing in slags, the existence of which he explains by the presence of calcium ferrite, which has a lower oxidising effect than would be exhibited by ferric oxide acting as a base.

Dr. J. Sarek (Kladno) said that in blast-furnace work gypsum models representing the composition of slags found little application as they did not indicate many important changes in properties, especially of fusibility, due to small changes in the composition. Thus, a slag with 2·5 per cent. sulphur was normally liquid, and one of 3·0 to 3·5 per cent. did not flow, although hot and acidic. The proportion of the bases likewise influenced considerably the fluidity of blast-furnace slags, yet such changes could not be represented by the Mathesius diagram. It would be interesting to know if open-hearth slags exhibited similar inconsistencies due to slight deviations in composition which could not be expressed by a triangular diagram.

Professor R. Vondracek (Brno) said the procedure for accurately determining ferric oxide given in the paper was particularly valuable, and would make it possible in future to derive more reliable conclusions as to the function of that oxide in open-hearth slags. The difficulties arising from lack of adequate analytical methods were well known. The reduction of ferric oxide by the sulphuretted hydrogen liberated by sulphides made the figures published hitherto rather dubious. It might partly be accounted for by oxidation of the ferrous salt by Mn_3O_4, but the presence of the latter in the slag was doubtful. Dr. Quadrat had given figures that could be relied on for the amount of ferric oxide in slags, and they were materially higher than those given by other workers. To plot composition in a triangular diagram like that of Mathesius appeared attractive, but would be difficult of realisation. First, the function of an oxidising open-hearth slag differed substantially from that of a blast-furnace slag, the properties of the former being oxidising apart from their fusibility. Therefore, the iron oxide could not be considered solely as equivalent to the lime, nor the ferric oxide as equivalent to the silica or alumina. Hofman had shown that a slag with 48 per cent. CaO and 11·5 per cent. FeO had a melting point of 1430 deg. Cent., while one with 30 per cent. CaO and 24·6 FeO melted at 1170 deg. Cent. Colclough had shown that ferric oxide could form a stable compound with CaO of the spinel type, the existence of which was demonstrated by Stead. He (Professor Vondracek) recommended expressing composition of slags in molecular percentages, which gave more comparable figures than the weight percentages.

Professor A. M. Mitinsky expressed the view that a triangular diagram could not furnish data for open-hearth slags. A basic slag was a system of many components, and being independent of the mode of its formation, the velocity of its chemical reactions and its chemical affinities would vary with the temperature. Small differences in chemical composition might produce new phases. He did not think it was correct to regard ferrous oxide in basic slag as a base in the same way as CaO.

Mr. T. P. Colclough (London) said that he was in agreement with the previous speakers that that representation of the constitution in the form of a triangular diagram was, to say the least of it, of little value, if not misleading. In the first place, in an open-hearth furnace, one did not in general, attempt to get a slag which was in equilibrium; and the triangular diagram, in general, could give, if it was to be stable, equilibrium conditions. What one was rather after was a slag which should have a superabundance of some element or constituent which stimulated the reactions so as to get the greatest output in the minimum time. Therefore, to represent the components of the slag in a triangular diagram might be far from helpful. He agreed with the last speaker that the triangular diagram might be misleading, because everyone who was familiar with the operation of open-hearth furnaces would know that one could increase the fluidity by a variety of means, and therefore the diagram would not be of much help.

The President said that Professor Quadrat would reply to the discussion in writing.

One or two of the speakers seemed to have spoken of the combination of oxide of iron and lime as though it were something new. Dr. Percy, fifty-six years or more ago, had melted together lime and oxide of iron, and got a deep red crystalline compound. He mentioned that because he had got the feeling that English people were rather in the habit of burying any original work they did instead of advertising it, with the result that other nations got the credit.

At the second technical session, held on Tuesday, September 16th, Mr. H. C. Wood presented a paper on "Open-hearth Furnace Steel Works: A Comparison of British and Continental Installations and Practice," which was then discussed.

OPEN-HEARTH FURNACE STEELWORKS.

The progress of the steel industry in Great Britain, looked at from a technical point of view, is one of such absorbing interest that the author has been prompted, after twenty years' observation, to make an examination of the development and the present-day position in this country in comparison with the leading steel-producing countries of the Continent. In doing so he restricts himself to the Siemens-Martin process solely, owing to the fact that practically the whole of the output of steel in Great Britain to-day is made by this process. The reasons for this are well known and do not need referring to here.

On the Continent, on the other hand, the Siemens-Martin process has for over fifty years found a very strong competitor in the basic Bessemer converter, or "Thomas" process, as it is generally called. Without a doubt, this competition between the two leading steel-producing processes has given the followers of each process every incentive to improve their practice and performance to the greatest possible degree. This applies in particular to the Siemens-Martin process, which, apart from the fact that it lends itself better to the manufacture of a very wide range of steel qualities and the utilisation of large quantities of scrap iron, has been susceptible to large variations in the method of working charges, and in the design of furnaces and the material-handling equipment employed, in order to make it more capable of competing with the lower cost of production of Thomas steel usually encountered.

With a view, in the first place, to enabling a comparison of the tonnages of steel manufactured in Great Britain and in the leading continental steel-producing countries to be made, reference should be made to Table I., which gives the outputs for the years 1910, 1913, 1920, and 1928 for Great Britain, Germany and France, and for Belgium, Italy, and Czechoslovakia—as far as these are available—divided into Siemens-Martin, Thomas, and other processes. From this it will be seen that in the case of Germany, the largest European producer of steel, the Siemens-Martin process to-day holds a highly important position, the tonnage produced approximating very closely to that of Great Britain, whilst the total tonnage of steel made by all processes is nearly double that of the latter.

A comparison of the practice followed and the results obtained in Great Britain and Germany appear to be of particular interest, seeing that the tonnage outputs are so similar. They will, therefore, be dealt with first:—

Great Britain.—In Great Britain very considerable extensions to existing Siemens-Martin steel plants were made during the war period, and in several cases entirely new installations have been constructed. Since the war, further new plants—notably at Clydebridge, Appleby, Crewe, and Consett—have been built, and these have been laid out on thoroughly modern lines. In many cases, however, where the reconstruction of existing furnaces or plants as a whole has been long overdue, the financial stringency prevailing has caused postponement of the work. Prior to the outbreak of the war, British open-hearth steel-making plants were for the most part handicapped by lack of space and efficient material-handling equipment. Many of them had grown up from small units on a limited space area, the result being that no room was available for modernisation of the

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nstallations in question. Labour costs and fuel consumption were high, and the tonnage outputs low. During the war, much good work was done in enlarging and increasing the output of existing plants in order to meet the rapidly increasing demand for steel, and several entirely new plants were constructed. Due, however, to the urgency dictated by the situation, it was in some cases not possible to give sufficient consideration to the situation or the planning of such plants to ensure their utility and general efficiency in post-war days. The result to-day is that in several cases well-equipped steel plants are situated remote from blast-furnaces, and are accordingly deprived of the advantage of working hot metal. They are, further, dependent on producer plants for their supply of gas, and only in a very few instances is the employment of coke oven gas or a mixture of that with blast-furnace gas possible.

The size of furnace generally installed in recent years is of 70 to 80 tons capacity in the case of fixed furnaces, and 150 to 250 tons in the case of tilting furnaces. There are, of course, many smaller units in use suited to meet the special conditions obtaining in the particular works in which they are installed. Larger units of the fixed or tilting variety respectively than those mentioned are rarely met with.

TABLE I.—*Production of Steel Ingots and Castings.*

Country.	Year.	Open-hearth.	Converter.		Other processes, including castings.	Total.
			Acid.	Basic.		
		Tons.	Tons.	Tons.	Tons.	Tons.
Great Britain	1910	4,595,366	1,138,103	641,012	—	6,374,481
	1913	6,063,175	1,048,772	551,929	—	7,663,876
	1920	7,984,100	552,500	268,400	262,300	9,067,300
	1928	7,831,300	475,900	—	212,500	8,519,700
Germany	1910	5,113,758	171,108	8,030,571	383,201	13,698,638
	1913	7,613,904	155,138	10,629,697	536,350	18,935,089
	1920	5,615,555	45,102	3,219,624	397,601	9,277,882
	1928	7,509,453	28	6,548,027	459,595	14,517,103
France	1910	1,137,397	105,582	2,136,558	33,767	3,413,304
	1913	1,582,478	252,704	2,806,475	45,209	4,686,866
	1920	1,255,120	60,188	1,656,972	78,116	3,050,396
	1928	2,688,648	80,588	6,586,214	144,078	9,499,528
Belgium	1910	—	—	—	—	1,944,820
	1913	—	—	—	—	2,466,630
	1920	—	—	—	—	1,253,110
	1927	399,890		3,192,600	87,680	3,680,170*
Italy	1920	633,537	—	—	140,224	773,761
	1927	1,383,561	—	—	212,209	1,595,770
Czechoslovakia	1920	—	—	—	—	973,006
	1927	—	—	—	—	1,732,000

* Includes Luxemburg.

Germany.—Owing to the loss of the Lorraine ore fields and the difficulty of obtaining a sufficient supply of ore at reasonable prices as a result of the war, Germany has been faced with the necessity of paying greater attention to the pig iron scrap process in order to bring the tonnage of steel up to the desired level. This has necessitated the extension of several existing open-hearth steel plants and the construction of new ones. Great attention has been paid to the choice of the most suitable sites for these works, consideration being given to the possibility of linking up such new plants with existing blast-furnaces and rolling mills. The questions of direct shipment of finished products by water and the availability of coke oven gas for heating purposes have also received due consideration. However, many open-hearth steel plants built prior to 1914 already possessed these desirable features, the result being to-day that practically the whole of the large-capacity open-hearth plants in Germany are found to be part of a composite installation consisting of coke ovens, blast-furnaces, steel furnaces, and rolling mills. In many cases, basic or Thomas converters are installed in the same plants, and the open-hearth furnaces are placed in direct competition with them, and take their molten iron from the same source of supply, this having the added advantage that the same storage mixers will serve both steel-producing plants. It may be mentioned that the duplex process of steel-making—that is, the combination of converters and open-hearth furnaces—is followed at the Huckingen works of the Mannesmann Company, where basic converters of 30 tons capacity have recently been installed to operate in conjunction with already existing 40 to 80-ton open-hearth furnaces producing steel for the weldless steel tube-making industry.

TABLE II.

Size of furnace. Tons.	Great Britain.	Germany.
10 to 12	14	40
15	12	65
20	13	53
25	20	39
30	42	78
35 to 40	116	66
45 to 50	145	53
55 to 60	103	39
70	69	10
80	13	18
100	8	11
120 to 300	25	6
Total number of furnaces	580	478

In the construction and equipment of open-hearth steel plants in Germany, great importance has rightly been placed upon the obtaining of big tonnage outputs per unit employed at a low fuel consumption, low repair costs, reduction of labour charges, and the general ease of control and scientific or automatic registration of working results. Particularly noteworthy is the important place which the tilting furnace has gained for itself in German steel works. When Dr. Voegler, chairman of the United Steel Works and President of the Verein deutscher Eisenhüttenleute, in 1911 had the temerity to place orders for the construction of three Wellman furnaces, each of 60 tons capacity, for the works of the Dortmund Union, of which he was at that time manager, voices were heard on all sides prophesying that the initial cost of the furnaces and the upkeep charges would be so high that they could not compete with fixed open-hearth furnaces, even for the working of molten metal charges. So favourable were the results obtained, however, that the furnaces were not only able to convert charges at a cost very closely approaching that of an entirely up-to-date installation of Thomas converters in the same works, but they demonstrated their ability to produce steel of every desired quality, and the capacity of the plant was soon still further increased by the addition of two further furnaces of similar construction, but slightly larger dimensions. Arising out of this favourable introduction of the tilting furnace, many further important installations were planned and built, and to-day the tilting furnace may well be termed the most popular steel-producing unit in that country. Constructors of fixed open-hearth furnaces have, on the other hand, been spurred on to make improvements in the design of such furnaces in order to maintain their position in competition with the tilting furnace. The fact remains, however, that since the year 1912 no Siemens-Martin steel works of importance has been built comprising fixed furnaces only. On the other hand, those high-capacity plants of Dortmund Union, Krupp, Rheinhausen, and Berge Borbeck, also that of the Bochumer Verein at Hoentrop, are composed of tilting furnaces only, and many such units have been added to other plants which were composed hitherto solely of fixed furnaces.

The sizes of furnaces mostly favoured in modern plants are of 50 to 60 tons capacity in the case of fixed furnaces and 80 to 180 tons for tilting furnaces, although there is one of the latter variety of 200 tons capacity, working the Talbot process, installed at Meiderich.

Published statistics giving the number of open-hearth furnaces existing in Great Britain and Germany, including those installed in steel foundries, will be seen in Table II. This table reveals the somewhat remarkable fact that of small-size furnaces Germany possesses a far greater number than Great Britain, whereas in respect of units of 35 to 40 tons capacity and upwards, the latter shows a great numerical superiority. The total furnace tonnage capacity of the two countries shows approximately 17,000 tons for Germany and 32,000 for Great Britain Having regard to the fact that the total tonnage of steel made by the open-hearth process is nearly equal in the two countries, the great furnace tonnage capacity difference may be due in part to the fact that perhaps a greater number of furnaces in Great Britain than in Germany are inoperative—probably 40 per cent.—and partly also to the greater tonnage obtained per unit in Germany. The number of tilting furnaces installed in the two countries is approximately 35 in Great Britain and 32 in Germany.

France.—Turning now to France, it is found that no developments of outstanding character in open-hearth steel works construction and operation are to be recorded. Modern installations have, however, been built at Le Breuil, Caen, Gueugnon, and Denain, and extensions made at other works. Fixed furnaces working on cold pig iron and scrap charges are almost universally employed, although tilting furnaces are to be found at Longwy and Hagondange, and are now under erection at Thionville. Preference is given to the working of molten iron in Thomas converters, but the output of open-hearth steel is steadily rising, and it may be confidently anticipated that the future will see a further extension of the open-hearth process in keeping with the increasing demand for better steel qualities.

Italy.—In Italy practically the entire tonnage of steel produced is made by the open-hearth process, and owing to the fact that apart from some deposits of lignite, limited in quantity and calorific value, the whole of the fuel used in the steel works has to be imported at a high cost from other countries. This has not unnaturally induced the steel producers to study fuel economy to the furthest possible degree, and considerable success has rewarded their efforts. Particulars are given later of working results obtained at Terni and Oneglia, which are of considerable interest, indicating as they do the good outputs obtained with a favourable fuel consumption.

Czechoslovakia.—With regard to Czechoslovakia, the open-hearth process again plays the predominant part in the steel output of the country, the principal centres of production being Pilsen, Trinec, and Witkowitz. In view of the forthcoming visit of the Institute to the latter works and of the important *rôle* it has played in the development of the open-hearth process, the working results detailed later in this paper will doubtless be found of considerable interest also.

In the next part of the paper the author describes the outstanding characteristics of modern steel plants, and gives a number of large drawings of complete plants and smaller drawings of details. He concludes as follow :—

The outputs obtained in continental steel works furnaces are found to be generally in advance of those made in Great Britain. Further, greater attention appears to be paid to the question of fuel economy and reduction of repair costs.

The best available mechanical equipment is universally employed, thus ensuring not only the economic, but also the quick handling of the incoming material.

Careful selection of scrap to be charged is practised to ensure suitability for the particular class of furnace employed and grade of steel to be made. Bundling presses are employed for dealing with light scrap, thus ensuring quick charging.

The high efficiency of the furnaces employed and the scientific system of control are notable features.

The time allowed for furnace fettling after tapping is cut down to the minimum.

Encouragement is given to the introduction of improvements in the design of furnaces, handling equipment, and general practice.

Dr. D. Adamson (Hyde, Cheshire) remarked that during the early development of the Siemens-Martin process British steel makers had not appreciated the advantages of having blast-furnaces, coke ovens, &c., close to the steel works, but they were now trying to overcome those disadvantages. In particular they were increasing the gas velocity through the furnace, which resulted in greater output. There was also a greater amount of waste heat available for the generation of steam. He had been told that at certain works no waste heat went into the stack, the gas temperature was very low and the furnaces were working efficiently. Low gas temperatures could result from leakage of air between the stack and the steel furnace. That meant not efficiency, but careless management, and poorer draught. He agreed that larger units would be of great economic advantage, but British makers had to make the best possible use of existing units, and he recommended increased flame velocity and improved port ends as indicated in the paper.

Mr. J. Henderson (Scunthorpe) said that Dr. Adamson had raised an important point in referring to the comparatively small units in use in Great Britain. Frodingham and Appleby had gone on developing until now a 300-ton unit was employed. Its only disadvantage was its size for the purpose for which it was used. Otherwise experience had been entirely favourable. By increasing the size of the furnace, and thereby the output, figures approaching those obtained on the Continent by more rational means were attained. The Appleby furnaces were credited with a fuel consumption of 17·5 per cent. of fuel per ton of ingot ; that was without allowance for waste heat recovery. He agreed that more steam ought to be got from the fuel, but the boilers were put in some years ago when information now available was lacking. In the paper he had found the statement that the Vitkovice tilting furnaces gave a yield of 103 to 105 per cent. That was a very fine figure and very close to the theoretical.

Mr. W. Simons (Cardiff) said that all who were faced with furnace reconstruction were very much interested in discussions as to the best type. The author had given a description of modern furnaces, although he had not referred to the Venturi furnace, which had been largely developed in America. He himself had come to the conclusion that the advantage lay with the tilting furnace. A charge could be better dealt with and unsuitable slags tapped out ; further, if properly constructed, the whole of the port end could be quickly removed. That was a great advantage from the point of view of labour costs.

Professor Bradley Stoughton (Bethlehem, Pennsylvania) said that, speaking from the standpoint of American practice, what aroused his admiration for the results of European practice was the great speed with which heats were brought out. In Europe, ironmasters were getting much greater outputs and much greater speed, with resulting economy in fuel and labour and increased furnace life. The Venturi furnace, with its sloping back wall, had been mentioned. He had been surprised to find that in that country they had, apparently, no sloping back walls. That was because the tilting furnace was so much used. There were few tilting furnaces in America, but when furnaces were relined sloping back walls were put in. In constructing open-hearth furnaces in America most attention was being given to the proper adjustment of fuel and air. It was standard practice to force the draught into the furnace and to suck out the burnt gases with fans. By that means greater control and better mixing were secured. Attention was also being given to refractories. For hearths dolomite was no longer used, but the best magnesite. Such hearths made up with a small amount of hydraulic cement would last a very long time.

Mr. D. Sillars (South Bank) said that the tilting furnace had come to stay. His experience was that up to, say, 100 tons, the fixed furnace still held its own ; above that the tilting furnace was more economical and presented many advantages. He disagreed with the author on the question of the quality of steel made in a tilting furnace ; that is, distinguishing between a large tilting furnace and a small furnace, tilting or fixed. He was convinced that the results for very high quality steel were better in the small furnace. The yield figures given for the fixed furnace were remarkable ; 94 to 95 per cent. yield on a fixed furnace or indeed any furnace was a very poor result. One could get quite good yields from a fixed furnace—about 100 to 103 per cent.

Mr. T. P. Colclough (London) said that the figures given were particularly valuable as showing the great progress made on the Continent since the war. The striking feature was the hourly rate of production ; that was the final criterion as to the cost of manufacture. For rapid production it was essential to have a hot flame properly directed on to the metal. One way was to use a better fuel to get a higher temperature of combustion. During the last ten years there had been a change of opinion in regard to coke oven gas. It had been commonly held that it should be used cold and raw. Now, both in Germany and America it was being mixed with blast-furnace gas. As concerned waste heat boilers, he would greatly regret it if a high yield of waste heat steam were aimed at because that was fundamentally wrong. The furnace was the place in which to use the fuel. The second way in which a high flame temperature could be obtained was to regenerate the gas and air to the highest possible temperature, using as much as possible of the fuel in the furnace and not in the chimney or the waste heat boiler. He was glad to find the statement that the only innovation of note, in the case of fixed open-hearth furnaces, had been the introduction of the Naissmith back wall in the United States. It was quite wrong to say that repair of the back wall was facilitated ; the wall was enclosed and no repairs were made. The total capacity of the Venturi furnaces built in America was greater than the open-hearth steel production of either Great Britain or Germany. The use of cooling water had been strongly

stressed. Ironmasters had developed that in America because they found it paid ; it reduced greatly the cost of repairs. With a minimum of water cooling, which abstracted about 1 per cent. of the heat of the fuel, one could get a life of 400 to 450 heats.

Replying very briefly, Mr. Wood said that he agreed with Mr. Colclough. He believed the Venturi furnace was giving very good results, although some American concerns were interesting themselves in the Terni furnace, which made him think they were not entirely satisfied with the Venturi. For special steels the small furnace had the advantage, but for commercial steels the tilting furnace was as good as the fixed furnace.

A paper on "High-frequency Steel Furnaces" was then presented by Mr. D. F. Campbell.

HIGH-FREQUENCY STEEL FURNACES.

A survey of the present status of the ironless induction furnace will show that its field of utility is much wider than is generally supposed. As is usually the case with new developments, it is supplementing certain processes, replacing various types of furnace in part, and though its limitations of size will prevent its application to certain operations requiring large ingots or castings, the rapidity of operation will have an important bearing on steel works practice outside the melting shop.

Ironless induction furnaces of the Ajax-Northrup type, having an hourly output of 20 cwt. to 25 cwt. have been operated since July, 1929, and smaller units of 5 cwt. capacity have been producing steel regularly since October, 1927, when the first tool steel from the ironless induction furnace was produced on a commercial scale in a Sheffield steel works.

At present the largest units are furnaces of 20 cwt. to 25 cwt. capacity per heat, giving an output of 20 tons per day, but the design of furnaces of 3 to 5 tons presents no technical difficulties, as many details of construction are easier in furnaces of large dimensions, while large motor generator sets can be built to operate at lower speeds and their design is well within established practice. There appears to be no technical reason to prevent the construction of units of any size that is commercially practicable, though economic considerations indicate the probability that units of less than 15 to 25 tons will be adopted, as in the case of steel making by the Bessemer or Thomas processes.

At present, the steel-making operations to which these furnaces have been applied are as follows :—

(*a*) The melting of high-class tool steels in acid-lined furnaces to replace the crucible process.
(*b*) The melting of low-carbon steel and alloys.
(*c*) The melting in an acid lining of rolling mill scrap produced from steel made in basic-lined arc furnaces.
(*d*) The melting of heat-resisting steel and refractory chromium alloys.
(*e*) The melting of nickel-chromium alloys.
(*f*) The re-melting of manganese scrap.
(*g*) The melting of hard materials, such as tungsten carbide.

In addition to the above established industrial uses, rapid progress is being made in determining the commercial value of the following metallurgical operations.

(1) The refining of steel is performed in basic-lined furnaces by slag reactions similar to those used in arc furnaces.

The refining operation is extremely rapid, owing to the circulation of the metal due to electrical forces. Furthermore, this movement constantly brings hot metal in contact with the underside of the slag layer, thus keeping it hot and maintaining ideal refining conditions at the slag metal contact surface.

(2) Duplex processes—either with the open-hearth or with electric arc furnaces in countries where the latter is the cheaper melting unit, where steel must be finished in an acid lining and only basic steel is available—show considerable promise.

(3) The conversion of molten pig iron into steel with the elimination of carbon, silicon, manganese, phosphorus, and sulphur, is carried out in basic-lined furnaces. The possibilities of converting liquid pig iron into steel are extremely interesting on account of the great rapidity with which the reactions occur owing to the intense circulation. The excessive over-oxidation of the basic Bessemer (Thomas) process is avoided, and by control of the circulation the conditions may be varied from those of a violently oxidising furnace to the comparative tranquillity of an open-hearth or crucible furnace, which is desirable for finishing processes.

The improvement in the efficiency of motor generator sets is remarkable. For 150-kW generator sets efficiencies of 73 to 75 per cent. were acceptable two years ago, but now 83 to 85 per cent. is obtainable for this size of machine. This improvement represents about 70-kWh per ton in normal practice, or about £200 per annum when using electricity at 0·6d. per kWh and melting 100 tons per month. British motor generator sets of 400-kW output are now giving 84 to 85 per cent. efficiency, and 650-kW sets an overall efficiency of 88 to 89 per cent., thus reducing the conversion losses to comparatively low figures.

Improvements in condensers have been rapid, aluminium sheet having generally replaced tin-foil, while water cooling by internal coils or by external cooling tanks has been generally adopted.

The construction of the furnace bodies, which must be either of non-magnetic materials or protected by magnetic shields, has undergone considerable modification. The smaller furnaces are built of asbestos cement boards, with a non-magnetic metal skeleton, and the larger ones may be built either in the same way or of steel plate with a suitable magnetic shield.

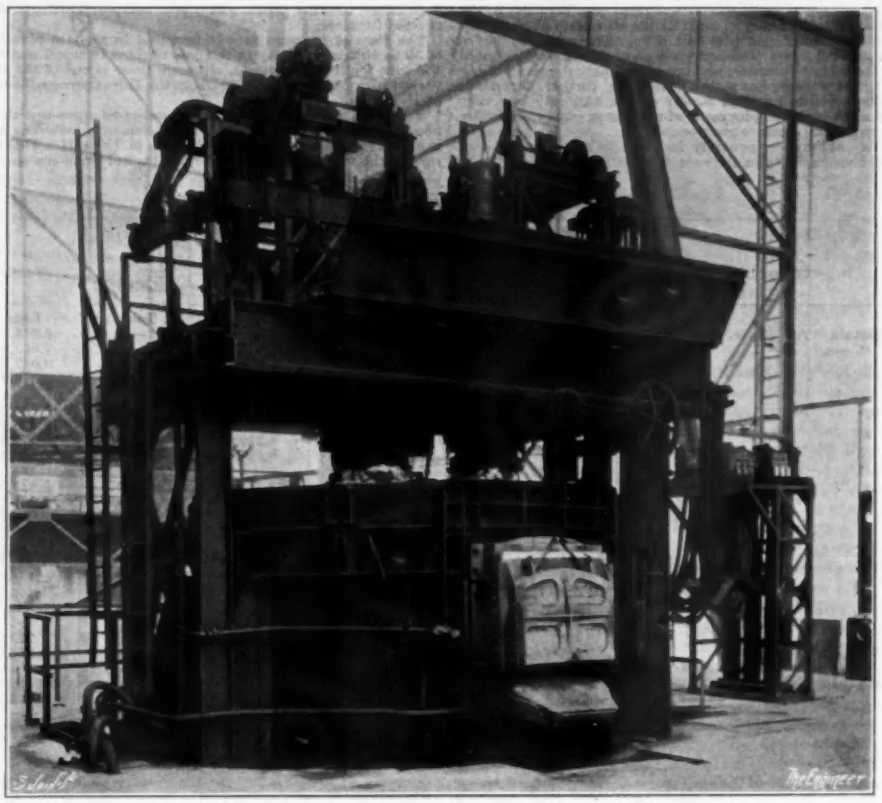
When melting alloy steels in 10-cwt. and 20–25-cwt. furnaces the time ranges between 53 min. and 69 min. with a consumption of 579 to 700 kWh per ton in the smaller and 65 min. to 87 min. and 525 to 700 kWh per ton for the larger furnaces.

The higher power consumption of the larger furnaces is not always due to a difference of efficiency in the melting equipment, as steel making practice varies very much in different works. There is a great variety of opinion about the importance of this time factor in steel making.

Dr.-Ing. Bernhard Matuschka (Ternitz, S.B., Lower Austria) said that Mr. Campbell had mentioned the growing importance of the ironless induction furnace as a most economical substitute for the crucible process. If the cost of power were not too high, the high-frequency furnace was decidedly advantageous, where high-quality steel was desired. It worked more cheaply than the small types of arc furnaces. It was no longer only a small furnace ; experience showed that working with the larger types was not more, but, in fact, less difficult.

Dr. W. H. Hatfield (Sheffield) said that the induction furnace was essentially one for special steels rather than for heavy production, but he could wish for a little more assurance that complete control was possible. Rapidity of production was an advantage, but it made quantitative control difficult. How was the casting temperature controlled ? Had the author any records which showed exactly what the amplitude of variation of the casting temperature was ?

SKODA WORKS—10-TON ELECTRIC FURNACE



Mr. J. Henderson (Scunthorpe) said that there were certain difficulties to be faced. There was the question of testing the steel before tapping, and then, again a 6-ton unit was not large enough for some operations. There was also the question of inspection and testing. The most serious point was the cost of power, which, at only a farthing per unit, amounted to a very high figure compared with Siemens practice.

Dr. A. McCance (Glasgow) said that a high-frequency furnace owned by his firm was working very well ; the methods of control were simple. They had not had sufficient experience as yet as to the quality of the steel produced, but it was at least as good as the best acid open-hearth products.

Professor Bradley Stoughton said that in his experience the very highest quality was obtained from the Ajax-Northrup furnace. Temperature control was very easy. One could get a better determination of temperature than from an arc furnace. He agreed with what Mr. Lantsberry had said when in America, that crucible quality was not regularly obtained in the arc furnace ; but it seemed to him that the high-frequency furnace, used as a re-melter without any black slag whatever, should give a quality equal to the very best.

Mr. F. W. Harbord (London) said that in the few experiments he had made he had found that one had great control over the temperature. He thought European experience had shown that this furnace was, for high-quality steels, a great advance on the arc furnace and had all the advantages of the crucible process and some of its own. The suggestion that it would supersede the 200-ton furnace was perhaps premature, but it would be an enormous advantage to make 200 tons per day in a 10-ton furnace. It would largely do away with cranes. One would teem directly into the furnace, use it as a ladle and tap the ingots.

Dr. Hatfield intervened to say that he could not understand Mr. Harbord's last remark. The use of a second lime slag, as was done in all the best British and American works, could result, in the Héroult process, in ingots virtually free from inclusions.

Mr. Harbord said that his point was that an over-oxidised Bessemer steel never gave the same results after taking to an open-hearth or electric furnace as if it had been worked down in the open-hearth to begin with.

Professor Bradley Stoughton expressed his conviction that if crucible quality was to be approached in the electric furnace no phosphorus or carbon should be oxidised in that furnace. A lime slag should be used at the start.

Mr. Campbell, in his reply, dealt with the remarks made concerning the arc and high-frequency furnaces. His view regarding the oxidising slag in the arc furnace was that, with alloy steels, if the dephosphorising and oxidation were done at the right temperature success resulted ; a plain carbon steel was more difficult to make. Great success had been attained in making almost every kind of steel in that furnace except carbon steel very low in manganese and silicon, but that difficulty was being overcome. Casting temperatures were, he thought, under control. It was easy to move the slag aside and use the ordinary pyrometric methods. Another way was to use the kilowatt meter, which gave very accurate control. The inspection and sampling of steel was a serious difficulty with small units, but in time that would be overcome, because with the high-frequency furnace there was much less variation and therefore less need of constant sampling. There was better control of oxidation than with any other process.

In bringing the session to a close the President proposed votes of thanks to the hosts of the Institute in Czechoslovakia, including his Excellency Dr. Josef Matousek, the Minister of Commerce ; his Excellency Mr. Joseph Addison, H.M. Minister Plenipotentiary in Prague ; Dr. Sykora and Monsieur Lubina, President and Honorary Secretary respectively of the Society of Czechoslovak Engineers ; and other members of the Executive Committee, and also to the Lord Mayor and Municipal Authorities of Prague.

Mr. W. Simons then proposed a vote of thanks to the President for the able manner in which he had discharged his duties, and the President, in reply, expressed his gratification if what he had done had met with the approval of the assembly.

VISITS.

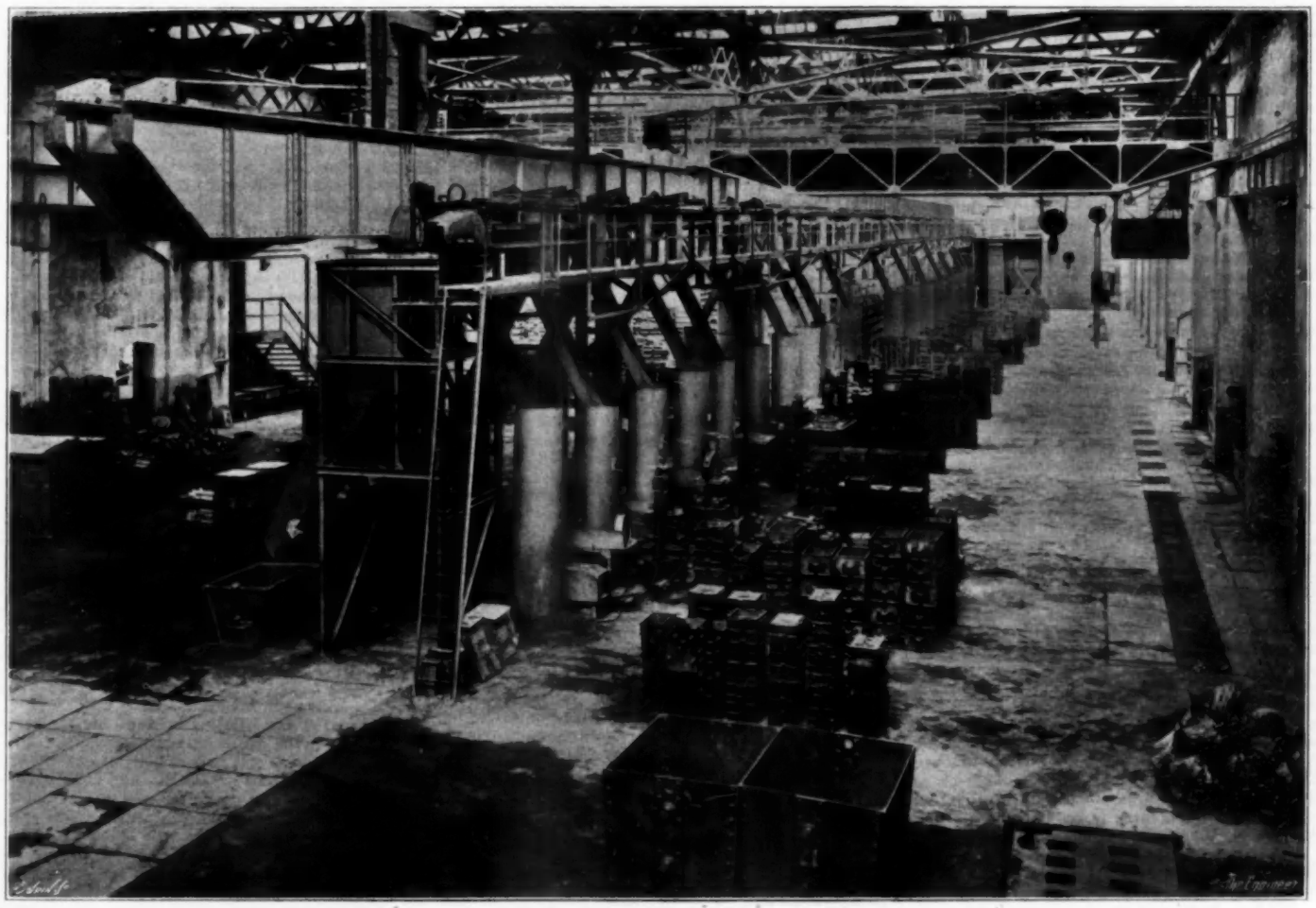
The Skoda Works, Pilsen.

The corporation to which the Skoda Works at Pilsen belongs is probably the largest combination of engineering and metallurgical works on the Continent, possessing as it does no less than nine large works in Czechoslovakia, apart from a number of repair establishments scattered over various parts of the Republic. The works visited alone employ a staff of 25,600 workpeople and clerks. They occupy a compact diamond-shaped area over a mile in length and nearly ¾ mile across (560 acres). The steel works are incidental to the engineering activities, and most of the steel made at the works is consumed in the various departments. The products include iron and steel castings and forgings in ordinary grey iron, special cast irons, and a very wide range of ordinary and special steels ; forged parts up to 105 tons in weight ; rolled and drawn sections ; mining and metallurgical machinery, marine and locomotive products of every description, engines, turbines, motor cars, lorries and aeroplanes, besides specialised machinery and plant for all kinds of industrial applications, cranes, and bridge and girder work. This list is by no means exhaustive, but may serve to indicate the main branches and departments into which the activities of the company are divided. To these should be added munition work of all kinds. Notwithstanding that fuel economy is observed throughout the works with the utmost efficiency, and that all fuel consumption is most carefully and scientifically controlled, and waste heat utilisation developed to the utmost extent, the coal consumption at these works alone amounts to close on 1100 tons per day.

There are two iron foundries, one for the produc-

SKODA WORKS, PILSEN

GREY CAST IRON FOUNDRY FOR MOTOR CYLINDERS



ELECTRIC STEEL CASTINGS FOUNDRY

tion of heavy castings up to 85 tons in weight, the other for the mass production of smaller castings. In the former there are five 7-ton cupolas, a 4-ton electric furnace, and an oil-fired furnace for special mixtures. The other, known as the Upper Foundry, contains six cupolas, and an electric furnace in which in special cases metal is prepared by a duplex process, *i.e.*, melted first in a cupola and finished in an electric furnace. An elaborate sand-conveying plant serves both foundries, the sand being sent by compressed air to the various sections of the moulding floors. These, and the adjoining pattern and core shops, are fully provided with labour-saving devices, as is likewise the non-ferrous metal foundry, a spacious, airy and well-lighted building, 145 m. in length and 64 m. in width. Each of its bays is specialised for the melting and casting of different metals and alloys, and this foundry is provided with nine 2-cwt. gas-fired crucible furnaces for melting brass, and other copper alloys, as well as an 800-kilo. "Detroit" two-phase electric tilting furnace and a battery of smaller furnaces for aluminium and light alloys. There is also a 2-ton barrel-shaped scrap melting furnace of the tilting type. For heat-resisting parts in these furnaces considerable use is made of the firm's special heat-resisting metal "Ferchromit," and linings of pure kaolin are likewise extensively employed. Brass and other alloy ingots are cast in water-cooled moulds on the Ericsson system.

The steel department at the Skoda Works has recently been reconstructed, so as to get the whole of the open-hearth and the electric steel furnaces in line. The object of the department is to furnish steel to the steel foundry, which makes castings up to 80 tons in weight, both in ordinary steel and in alloy steels of any composition needed; to supply ingots for the forging departments, which are capable of producing such forgings up to a weight of 105 tons; and, finally, to supply the rolling mills, there are in the melting shop, which is over 460 yards in length, five basic open-hearth furnaces built on the modified März system, and four acid open-hearth furnaces of the ordinary Siemens-Martin type. There are also two 6-ton Heroult furnaces and one 10-ton Fiat electric furnace—see illustration, page 363. The furnaces are cold charged, and have water-cooled doors and air ports, and in the manufacture of the quality steels for special castings the most careful practice in the selection of all materials and in the working of the charges is observed. During the oxidising period, while dephosphorisation is taking place, the slag is twice skimmed off, and not till then is carburising effected, and the special alloy metals added. In the making of acid grades only low phosphorus Swedish pig is used, although of late high-grade British hematite has been employed. The basic steel furnaces melt pig iron from Trinec, in addition to imported grades.

As was described in a paper read at the Institute meeting at Prague, in order to secure the utmost homogeneity in large ingots of special steels and on other occasions where particular need exists for the maximum soundness attainable, the Harmet process of casting the ingots under high pressure has been adopted at these works, with the most satisfactory results. The metal is poured into specially tapered moulds and subjected to an extremely high pressure in a hydraulic Harmet press. Ingots up to 60 tons in weight have been subjected to this process. The quality of Skoda steel is proverbial, and in the discussion which ensued on the reading of the paper referred to, Professor Bradley Stoughton bore testimony to the high esteem in which, even in America, Skoda steel is held.

Apart from the ordinary steel foundry, which, at the time of the visit, appeared, like other departments of these vast works, to be working to capacity, there is an electric steel foundry, in which for the most part the equipment is specialised for the production of small thin-walled castings of intricate design, used, wherever possible, in the place of small forgings, or in substitution for built-up parts of sheet steel.

The forging department of the Skoda Works is divided into two sections, the "Main Forge" equipped for the manufacture of the very largest forgings, and the "Small Forge" wherein medium and small forgings, as well as die forgings, are made. The equipment of the former consists of four steam-hydraulic presses having capacities of 1000, 1500, 2500, and 5000 tons respectively. The reheating furnaces in the heavy forge, of which there are nine, producer gas fired, have movable hearths capable of sustaining loads up to 120 tons. Twenty-three overhead and other cranes handle the ingots from the furnaces to the presses, and during the operation of forging are controlled by revolving gears, which render unnecessary the practice followed in many forging departments of using counterweights for this purpose. The smaller forge is equipped with a large number of hammers, and with presses up to 750 tons. For the manufacture of die forgings a large "Eumuco" drop hammer, the tup of which weighs 8 tons, has been installed. The heat treatment of all forgings is the subject of the most minute care, inspection, and control. For oil quenching, tanks up to 25 yards in depth have been provided, while annealing furnaces fired with cleaned producer gas and provided with pyrometric control, both of the horizontal and of the vertical types, have been installed, some of them being 65ft. in length and capable of accommodating forgings up to 60 tons in weight.

It is impossible, within the limits of a short notice, to do more than deal briefly with what are perhaps the most important departments of all of the great Skoda Works. These are the machine shops, large and small, devoted to the manufacture of machinery of all kinds. In the locomotive department the visitors saw in various stages of completion part of a large order for forty locomotives for the Chinese Eastern Railway, of which twenty-four are in hand and another sixteen to be built. Amongst the huge machine tools with which the engineering departments are equipped may be mentioned a giant lathe with centres 72ft. apart; and another with a horizontal face plate for machining parts up to 40ft. in diameter. These and innumerable other machines have been employed in making machinery for all parts of the world—for Indian and South African Railways; crank shafts up to 70 tons in weight for ships in the United States, England, Holland, and Sweden; steel propeller brackets for the German liner "Europa" and a 65-ton rudder for the French steamer "La France"; Ilgner forged fly-wheels for Germany; cranes, bridges, turbines, and oil engines for all parts of the habitable globe, including our own country and our Dominions. To the manufacture of these and other products the whole of this great works is subsidiary, including the tire mills, the tube mills—Mannesmann system—and the many other departments which render the entire enterprise so wholly self-contained and self-sufficient.

The electric steel casting foundry and the gray cast iron foundry for motor cylinders are illustrated on page 363.

The central arrangement seen in the view of the electric steel foundry is a sand distributor from which the sand, already prepared at a central conditioning plant, is conveyed by compressed air to cylindrical bins, whence it is shovelled from the bottom by the moulders as required.

The British Association.

No. IV.* (*Conclusion*).

The Design of Steel Structures.

Section G (Engineering) met again on Wednesday, September 10th, when the morning was devoted to a discussion on the design of steel structures. Two papers on the subject were read, namely, "Structural Steel Design and Regulations," by Mr. J. S. Wilson—Recorder of Section G—and "Theory and Experiment in Structural Design," by Professor C. Batho. A third paper entitled "Standardisation of Design for Structural Steel Work," by Mr. J. S. Lewis, although on the programme, was not presented.

Mr. Wilson, in his paper—which, in its completed form, was not available at the meeting—said that regulations relating to the design of structures had developed from two sources, namely, partly from simple rules and guiding proportions which had been adopted with the object of simplifying the processes of design and to render details of design more consistent, and partly to make it possible to produce designs which might be strictly comparable as to strength, workmanship, and durability. The rules and regulations which had been used or had been proposed had had for their object one or other of the following:—(1) To facilitate design, keep details consistent and eliminate personal eccentricity (or genius?) of the designer; (2) to simplify manufacture and cheapen production; (3) to enhance durability by increasing the stiffness, thickness or riveting of parts or members above that required by considerations of strength only; (4) to codify methods of calculation of loads and stresses so that engineers working independently might get strictly comparable results; (5) to give structures a strength capable of withstanding a standardised system of loading while the stresses in their members did not exceed specified maximum intensities. Examples of each type of rule would, he said, be discussed in the full paper when completed. The adoption of well-considered rules of the first four types, said the author, aided good design and resulted in what was sometimes called good practice. Selections of rules based on extensive experience had been put together in the form of designing specifications, but the idea that a multiplicity of rules and regulations could take the place of experience or prevent bad or weak design on the part of the inexperienced was strongly to be deprecated. Designing specifications in relation to loads and the corresponding limiting stresses were of two fundamentally different types. In one type the maximum intensity of stress allowed in a member was adjusted to suit the position of the member and the severity of the loading conditions in that member. In the other type the stress was limited to a nominal maximum for all members, but the loads carried by different members were adjusted according to an empirical formula which increased the loading where the conditions were more severe. Regulations relating to stresses had an important influence on weights and costs of structures and, for structural work sent abroad, the country which adopted conservative practice and low limiting stresses, though producing comparatively robust and durable structures, might be seriously handicapped in international competition.

* No. III. appeared September 26th.

In the course of some further remarks, Mr. Wilson, referring to the American regulations, commented on that specifying that flange angles must form as large a proportion as possible of the flange area of a girder. He also expressed the view that we were bound to use American textbooks in this country in teaching structural designs.

The President, after drawing attention to the fact that difficulty was sometimes obtained in getting plates rolled sufficiently thin, with the result that the web plates were sometimes thicker than was necessary, referred to the Blackwell Island Bridge, which, although it was strengthened to take a greater load than was originally intended, was found, after investigations following the failure of the first Quebec Bridge, to be insufficiently strong for the loads it was carrying, and it was decided to remove the concrete roads on the bridge and replace them with flat plates and wood block flooring to reduce the permanent load on the bridge. The President added that the Forth Bridge, weight for weight, was, in his opinion, the best design yet produced. Another detail of steel structures to which attention should, he said, be paid was the danger of rust forming between plates of structural members placed close together, some experience of which had been obtained in connection with the Charing Cross Bridge.

Dr. R. E. Stradling, referring to the Committee appointed by the Department of Scientific and Industrial Research to investigate the question of structural design, said that that inquiry would take the form of a discussion between the officials of the Department and firms engaged in the industry, with the object of arriving at agreed views on matters relating to efficiency and economy in structural design. The structural steel industry, faced, as it was, with exceedingly keen competition, was particularly desirous to see what could be done in that direction, and, in view of the conditions prevailing, the Department would share the cost of the investigation with the industry. Representatives of the Institutions of Civil Engineers and Structural Engineers, as well as of the industry, and, of course, of the Research Department, were on the Committee, and it was hoped that the work done as regarded the theory of structures appertaining to aircraft—which had led to such accurate methods of design as had been indicated in the papers read before the section on the trend of airship construction—might find an outlet in general steel structural work. The first portion of the Committee's work related to building, but it was intended to deal with bridge work during the course of the inquiry, whilst building regulations also came within the scope of the investigation.

Mr. H. H. Burness pointed out the essential difference between conditions here and on the American Continent. Both in America and Canada, he said, the policy was cheap construction and short life, whereas in Great Britain durability was the first consideration. At the same time, he thought the American regulation, referred to by Mr. Wilson, that flange angles must form as large a proportion as possible of the flange area of a girder, was a reasonable one. The tendency to use wide plates and small angles in the flanges rendered it difficult to provide a proper distribution of the stress from the angles to the plates. Another point mentioned by the author was that we in this country were bound to use American textbooks in teaching structural design. That was largely true, and it would be of great assistance in teaching work if there were available books by British authors dealing both with the theory of structures and with practical work.

Mr. Wilson, in a short reply to the discussion, said that no girder in this country had ever failed or given trouble from the fact that small flange angles were employed. The point he wished to stress most in his paper was the detrimental effect that harsh specifications in this country must of necessity have in international competition. Moreover, there was the point that, in South America, for example, and also elsewhere, engineers were generally familiar with American specifications, which were available in several languages, whereas British specifications were often unknown. Again, American specifications were made to suit the American steel, and therefore it would be impossible to employ them in the case of bridges designed in this country without using a great deal of unnecessary material, inasmuch as British steel was harder than American steel. At the same time, if specifications were so framed that the stress, when using British steel, was increased, the position of British steel makers and others in the overseas market would be considerably improved.

Theory and Experiment in Structural Design.

Professor C. Batho then read his paper on "Theory and Experiment in Structural Design."

He pointed out that a field of investigation of importance to the structural engineer was the development, by analysis and experiment, of exact methods for the calculation of the stresses and deformations in a structure, and the determination of the conditions which governed its breakdown under excessive loading. Methods developed might often be too complicated to apply exactly under commercial conditions of design. That, however, should not prevent every effort being made to reduce the results as far as possible to forms which might be embodied in specifications or laid down as methods of design, the aim

being to produce designs which, when considerations of workmanship, standardisation and structural elements, planning, appearance and other factors were taken into account, resulted in the utmost economy of material consistent with complete safety. The problems involved fell into two groups: (1) consideration of the structure as an elastic framework; (2) the study of the distribution of stresses and deformations in the members and of the manner in which the connections transmitted the forces and affected the strength of stability of the structure.

Statical indeterminate structures were often necessary or desirable, and the author suggested that there was a field for investigation in the development of quick approximate methods for the preliminary design of such indeterminate frameworks. The difficulty of calculation of redundant structures was often exaggerated owing to neglect of systematic treatment by means of deformation diagrams and influence lines which had been developed mainly in Germany.

Professor Batho explained that it was customary in this country in designing building frames to treat them as consisting of beams and columns, except in dealing with wind stresses—if they were taken into consideration—but that he considered it doubtful whether that method, besides being illogical, led to economical design, and suggested that investigations, including a complete analysis of frames as elastic structures having rigid or semi-rigid connections, combined with intensive experiments on the stresses, deformations, and slips in the connections, should lead to the development of more rational and economical methods. As a matter of fact, several methods were available for the analysis of an elastic framework of this type, including the slope deflection method, whilst Beggs experimental method was suggested as a valuable aid in the design and investigation of statical indeterminate structures. At the same time the calculation of a structure as an elastic framework took no account of, and gave no information concerning, the manner in which the actual connections behaved or how they affected the distribution of stress in the members. Many experiments had been carried out, particularly in America and Germany, but many more needed to be undertaken.

Discussing the problems involved in the second group, Professor Batho pointed out that they were largely experimental and included (*a*) intensive laboratory exploration of the strain and deformations in structural elements, connections and built-up members; (*b*) laboratory tests to destruction; and (*c*) experiments on actual structures.

Examples of these problems were discussed in the paper, and the desirability of investigating the simpler elements of construction before attempting to analyse the results of tests on complete structures was pointed out. The author stated that whilst the most usual test, namely, that in which the breaking load alone was recorded, was better than no test at all, it seldom threw any light on the causes leading to breakdown. Moreover, it was an extraordinary fact that even that simple form of test appeared sometimes to be omitted in framing rules for design. An example of that was the clause which was formerly contained in many specifications to the effect that rivets should not be used in positions where they would be subjected to tension. Tests carried out in Germany, Canada, and the United States, however, had shown that a riveted joint loaded so that the rivet was in tension, was capable of sustaining a tension equal to and often exceeding the tensile strength of the material of the rivet, and those results were now beginning to be reflected in specifications. The Canadian Engineering Standards Association's specifications allow 10,000 lb. per square inch, and although in the author's opinion that seemed to be on the conservative side, he commented on the fact that most specifications omitted all mention of the use of rivets in tension, and emphasised the need for obtaining not only the breaking load, but also information as to the behaviour of the specimen before that load was reached.

Referring to experiments carried out by himself in 1916 upon riveted joints, Professor Batho suggested that those joints as at present designed were usually unsafe, and that it was often desirable, both from the point of view of economy and ease of erection to replace rivets by bolts. Experimental investigations on bolted joints were in progress at the University at Birmingham.

The introduction of welded structures had introduced many new problems, and the paper made the comment that the safety of those structures could not be fully relied upon until a practicable method of inspecting the soundness of the welding in the field was developed.

Professor Batho, in conclusion, said that his hope was that a closer study of the work already done, together with a prosecution of further investigations, would lead to the possibility of placing specifications and methods of design on a thoroughly scientific footing. That, he thought, should result in greatly increased economy and soundness of design, and, at the same time, enable us, as more rational methods were adopted, to frame more stringent regulations to govern design. That, however, could not be accomplished until the present rather chaotic organisation of structural engineering in this country was improved.

Mr. J. S. Wilson expressed the view that experimental tests to destruction did not convey all the information that was sometimes imagined, and certainly tests to destruction of riveted joints did not convey much. Referring to the failure of the first Quebec Bridge, it was pointed out that although the preliminary designs were made and the weights got out, a final estimation of the weights was impossible, owing to lack of staff to check the calculations. Mr. Theodore Cooper, the engineer, threatened at one time to resign because he was not provided with a sufficient staff of assistants, but was prevailed upon not to do so. The fact was, however, that the failures were due to the additional weight not being properly provided for. Discussing the question of statical indeterminate structures, it was stated that confidence must depend entirely upon experience, and in many cases a brick or masonry arch or a steel arch would be stronger than a girder.

Dr. C. H. Lobban suggested that many troubles encountered in structural engineering were due to the fact that students only obtained a smattering of training in the theory of structures, and that a special course in structures alone should be provided. Incidentally, he mentioned that he was investigating the case of a six-storey building designed by ordinary methods in which no account had been taken of the rigidity of the joints, the connections between the beams and stanchions being regarded as flexible. He was, he added, using a purely theoretical method of analysis, but it would be many months before that work was completed.

Dr. R. E. Stradling, who had just returned from the Liége Reinforced Concrete Congress, expressed his surprise at the large amount of mathematical work carried out on the Continent on the subject. It might be true, as had been suggested, that the higher mathematics of the subject originated in this country, but they certainly were applied in practice on the Continent to a greater extent than here.

Mr. H. H. Burness said that the calculations for statical indeterminate structures depended very much upon the estimations made to begin with. In this country, moreover, we were returning to the determinate structure as far as the dead loads were concerned, using hinges at the abutments and centre, but the fact was that, once the bridge had settled down, the structure became statically indeterminate.

Professor Batho, replying to the discussion, said that there was, of course, a limit to the stiffening up of specifications. We must be careful not to make them of such a character that all work was standardised, but, of course, there was a very long way to go, especially with regard to buildings, before that could be said to be the case. At the same time, he did not think modifications of specifications on the lines that had been suggested would destroy either the function or the prestige of the engineer. As regarded the Quebec Bridge, he had always felt that the mistake made by Mr. Theodore Cooper was in the adoption of light latticing for members which were under excentric loading during erection, whilst the mistake in connection with the deadweight was due to the neglect of the enormous weight of the details. Incidentally, he mentioned that the investigation referred to by Dr. Lobban was being made at the Building Research Station, and he looked to it as likely to give exceedingly useful results. Speaking with regard to teaching in structural work, Professor Batho mentioned that at the Birmingham University, the course occupied four years, and that part of the fourth year course work dealt with statical indeterminate structures.

Electrical Terms and Definitions.

The Report of the Committee on Electrical Terms and Definitions was then presented by Professor F. G. Baily. It was pointed out that great difficulty had been experienced in getting agreement upon some of the definitions and units used in electrical engineering, and that difficulty has been traced to lack of precision in the definitions of the three fundamental quantities, namely, electro-static quantity, magnetic pole, and electric current. The International Electro-technical Commission had been dealing with the definitions of the practical units in electro-technics, and that Commission had also experienced the same difficulties as those met wth by the British Association Committee. As, however, at least one of the members of the British Association Committee was also a member of the International Electro-technical Commission, the matter was being discussed between the two bodies, whilst, during his visit to Bristol, Professor Kenelley, of America, had also been conferred with on the matter, and had been co-opted as a member of the British Association Committee. It was therefore recommended that the Committee should be reappointed as a link between the other bodies dealing with the difficulties. At the same time, the Commtitee proposed to submit a technical report suggesting a revision of the fundamental definitions of electrical science. That, said Professor Baily, involved international co-operation between physicists and engineers, and he concluded by suggesting that the centenary meeting of the British Association in London next year might afford a suitable opportunity for the discussion of the subject.

The Report and the recommendation that the Committee be reappointed were adopted.

Earth Pressures and Stresses in Overstrained Materials.

Professor W. Cramp then presented the fifth interim report of the Committee on Earth Pressures and the interim report of the Committee on Stresses in Overstrained Materials.

The Committee on Earth Pressures consists of Mr. F. E. Wentworth-Shields (chairman), Dr. J. S. Owns (secretary), Professor A. Barr, Professor G. Cook, Mr. T. E. N. Fargher, Professor A. R. Fulton, Professor F. C. Lea, Professor R. V. Southwell, Dr. R. E. Stradling, Dr. W. N. Thomas, Mr. E. G. Walker and Mr. J. S. Wilson. Thia Committee, it was pointed out, had met once since its last report, viz., on May 29th, 1930, when a visit was paid to the Building Research Station at Graston, Watford, to see the research work being carried out there by Professor C. F. Jenkin. The Committee was impressed with the fact that the investigation of the actual pressure and resistance of clay was very much more complex than previous investigations had suggested, and, indeed, the same might be said about sand. Professor Jenkin was, it was stated, on his guard against the many factors which might lead to quite wrong conclusions in that kind of research, and it seemed likely, it was added, that his work would lead to information and practical results. The Committee recommended that Professor Jenkin's and its work be carried on for a further period.

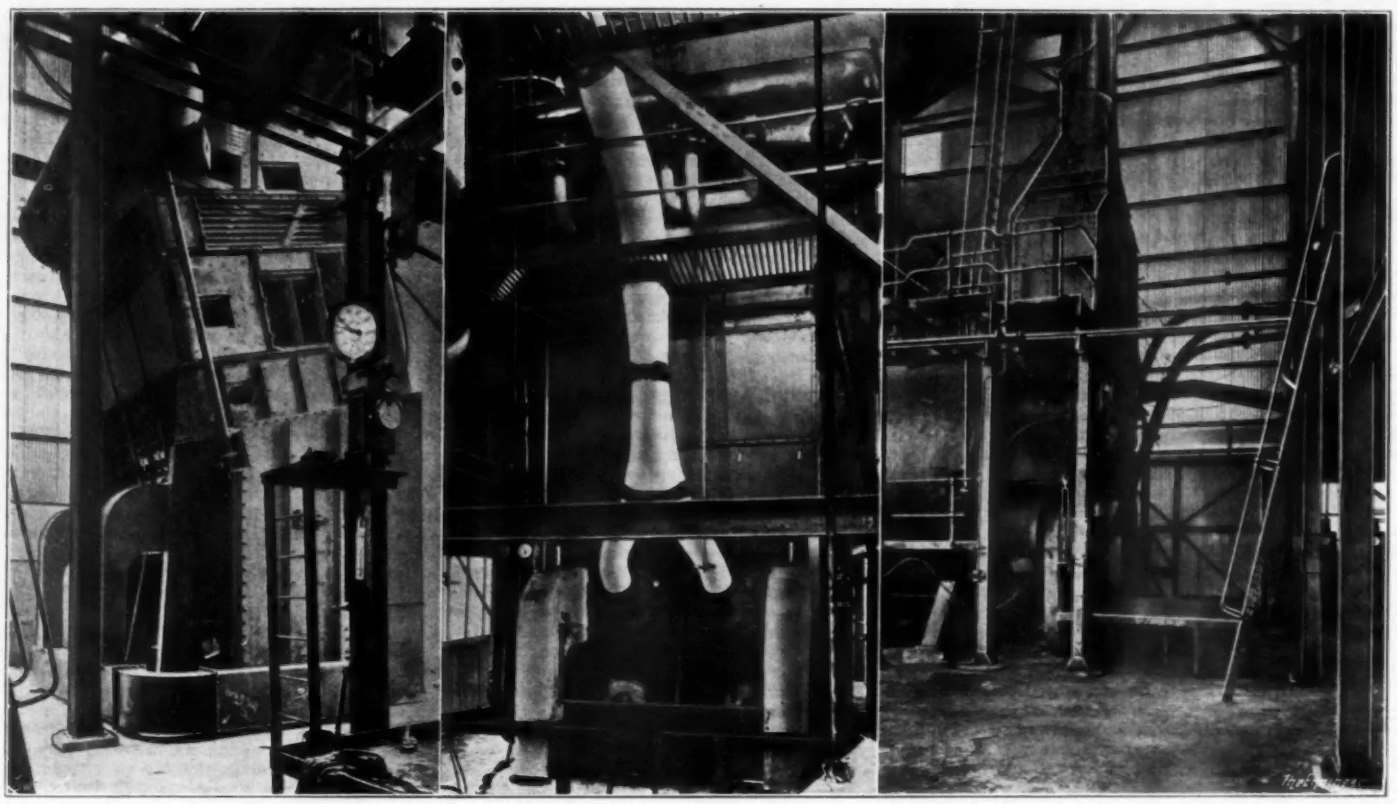
In a progress report, Professor Jenkin stated that since his last report, his apparatus had been removed to the Building Research Station, Watford. In August last he visited the large Berlin Research Laboratory known as Versuchsanstalt für Wasser und Schiffsbau (Testing Station for Water and Shipbuilding). That establishment was carrying out regular tests of soils encountered in connection with the new dock works at Bremerhaven on the following lines:—(1) The moisture content was determined by drying; (2) the grain size was determined by sieving and, in the case of finer grains, by water separation; (3) the specific gravity was determined by removing the air with carbon tetrachloride and then measuring the volume with water; (4) the proportion of carbonate of lime was determined by measuring the CO_2 given off when the grains were treated with sulphuric acid; (5) the nature of the grains was determined by microscopic examination; (6) the acidity was determined by measuring with an electric bridge, giving the hydrogen-ion content. Another test was carried out to ascertain the shearing strength of the soil. That was effected by a machine designed by Professor Terzaghi. The soil was diluted with an excess of water and then put in a thin layer between sand-filtering discs under a known load. The water was thus squeezed out until a stable condition was reached, which took about a fortnight. It was considered that the clay then contained the maximum amount of water possible under that particular load. The load usually selected was that to which it was subjected, *in situ*, but the clay was sometimes tested after having been subjected to other selected loads and, therefore, contained more water, or less, as the case might be. The shearing strength obtained represented the result of combined cohesion and friction.

Whilst Professor Jenkin's new laboratory was being built at Watford, he concentrated on the solution of problems presented by a very simple model of sand. Professor Jenkin believes that sand pressures are essentially connected with the packing of the grains, and he has investigated the pressure of ideal sand made up in uniform spheres. Rough experiments with Hoffmann steel balls showed, it was related, that they behaved very like sand. As the mathematical solution of the equilibrium of steel balls in three dimensions appeared to be very difficult, the two-dimensional problems were attacked, and a two-dimensional model was prepared which produced all the phenomena of "arching," which Professor Jenkin regarded as the fundamental property of sand. The model showed that there were limits which could not be passed by arching; thus, no arching could occur over a hole in the bottom of a box unless the depth of sand was greater than a certain proportion of the diameter of the hole. The same reasoning showed that sideways arching could not occur in sand if the depth of sand were small compared with the width. All previous experiments had, Professor Jenkin believed, been made with approximately cubical boxes, and attempts had been made to avoid arching by using larger and larger models. The solution, however, appeared to lie in the proportions and not in the size of the model. A measuring apparatus on those lines was now nearly completed, and preliminary experiments showed that it acted satisfactorily. The apparatus was designed to measure the force on a wall—vertical or battered—and to give the horizontal and vertical components and the point of application. In other words, to give the resultant force in magnitude, position and direction. The "wall" was about 2ft. long and 3in. deep. The clay experiments were held up until the new 3-ton testing machine, now nearly ready, was available.

The Committee on Stresses in Overstrained Material consists of Sir Henry Fowler (chairman), Mr. J. G. Docherty (secretary), Professor G. Cook, Professor B. P. Haigh and Mr. J. S. Wilson. The interim report

WATER-TUBE AND CYLINDRICAL MARINE BOILERS WITH PULVERISED FUEL FIRING

BABCOCK AND WILCOX, LTD., RENFREW, ENGINEERS



FIGS. 1 AND 2—550 LB. PRESSURE MARINE WATER-TUBE BOILER

FIG. 3—120 LB. PRESSURE MARINE CYLINDRICAL BOILER

stated that an investigation of the stress-strain relation up to and beyond the yield point was being carried out in the Engineering Laboratory at the Royal Naval College, Greenwich, by Mr. J. G. Docherty and Mr. F. W. Thorne, but the tests were not yet complete. It was hoped to publish the results soon. Professor G. Cook, in the Engineering Department, King's College, London, was investigating (*a*) the effect of non-uniform stress produced by torsion, flexure and internal pressure, on the initial yield point in mild steel, and (*b*) the stress distribution in the initial stages of plastic strain for those cases. It was hoped that the results of those experiments would be published in the autumn. It was also hoped that a full report of the experiments and also the other papers in the 1929 report of the Committee, would be presented with the 1931 report. The Committee asked to be reappointed for another year.

Both reports were adopted and the meeting closed.

During the morning the President, Sir Ernest Moir, having to relinquish the chair, Professor W. Cramp succeeded him. The President, before leaving, however, thanked the Recorder and all other officers of the Section for their services. Mr. J. S. Wilson (Recorder) acknowledged the vote of thanks and at the same time expressed appreciation for the manner in which Sir Ernest Moir had presided over the meetings of the Section.

Industrial Psychology.

Industrial psychology did not play such a prominent part in the proceedings of Section J (Psychology) as in many previous years, but reference may be made to a paper by Dr. C. S. Myers, F.R.S., Director of the National Institute of Industrial Psychology, in which he expressed the belief that we should see, before long, established in every important industrial university centre a lecturer in industrial psychology, whose duty it would be to give theoretical and practical instruction in the subject to certain students of engineering, economics and commerce. A further function of those lecturers, it was suggested, would be to train future investigators in industrial psychology and to act as consultants to local industrial and commercial firms, through the aid of influential local committees—constituted as the Committee of a branch of the National Institute of Industrial Psychology—and generally to encourage the directors of local concerns to employ in their businesses the aims and methods of industrial psychology.

Costing in Industry and Agriculture.

During a discussion on the value and limitation of costing in industry and agriculture before Section F (Economic Science and Statistics), Mr. A. Cathles suggested that a census of the costing methods of all manufacturers would be more valuable to industry than the census of population or the census of production. He alleged that inept, inadequate and inaccurate methods of costing were being employed, to a very great extent, by British manufacturers, who were estimating on unsound bases. It was fallacious to say that the only use of costing was in price fixing. The primary function of costing was to provide data which would assist the manufacturer to run his business efficiently. Mr. Cathles added that whilst, during the last ten years, British manufacturers had suffered from competition from countries in which wages had been both lower and higher than the wages paid here, the British manufacturer's lack of knowledge of the volume of his own fixed overhead expenses and of the actual incidence of those expenses on a falling output had also caused him suffering, and that only a scientific costing system would reveal the economic limit of price cutting. Never in the manufacturing history of this country was the need for sound costing greater than it was to-day, when foreign competition was keener and better directed than ever before.

Next year's meeting of the British Association will be the Centenary Meeting, and it is to be held in London. At the moment, of course, details of the nature of this special meeting are not available, but an appeal is being made for contributions towards a special fund so that the meeting may be on a scale commensurate with the importance of the occasion. In 1932 the meeting will be held in York.

High-pressure Water-tube Boiler Developments at Renfrew.

On Thursday of last week, September 25th, a party of over ninety engineers accepted the invitation of Babcock and Wilcox, Ltd., of London and Renfrew, to inspect some new high-pressure water-tube boiler developments at the firm's Renfrew factory and afterwards to make a trip on the Clyde turbine steamer "King George V.," which was, in 1928, equipped with 560 lb. pressure Babcock and Wilcox water-tube boilers, and has now successfully completed two summer seasons of tourist traffic on the Firth of Clyde. Excellent arrangements were made by the firm, and in the regretted absence, through illness, of Sir John Dewrance, the chairman of the company, Sir Robert Dixon acted as host. He was supported by another director, Colonel Greenly, Mr. A. Spyer, general manager, and Eng.-Admiral Whayman, of the marine department. In the article which follows we describe the principal features of the plants which were inspected by the members of the party.

High-pressure Boiler Making.

In our issue of December 7th, 1928, we dealt with the modern boiler engineering plant in the new marine boiler shop at Renfrew, and on the occasion of our visit last week we were pleased to see that most of the large machines were well employed. Several high-pressure boilers were going through the shops, and a number of long, large-diameter drums with riveted seams and ends, were to be seen in various stages of production. Members of the party showed keen interest in the preparing and planing of the plates, their bending in the 8000-ton hydraulic press, and the assembling, drilling, riveting, and caulking of the drums. We noticed that, for internal longitudinal seams, an air-driven caulking head of the travelling type is employed.

Several solid forged steam drums, which are manufactured at John Brown's Sheffield Works by that firm's special hollow forging plant, were seen in the shops. An interesting department was that set apart for the preparation and assembling of tubes and headers, in which the latest methods of tube bending, assembling, expanding and testing have been combined to form a very efficient section of the works. For the longest tubes, flash welding has now been adopted, and some ingenious tools have been devised to remove internal fins which are formed by the welded junction of tubes. A large butt-welder by A.I. Welding Appliances, Ltd., of London and Inverness, was, we noted, being put to work. Other departments visited included the structural shop, in which a series of cranes for home and overseas ports were seen approaching completion, and the stoker department, which appeared to be quite busy.

Well advanced in a special boiler-house is a 1575 lb. per square inch pressure, 850 deg. Fah., superheated steam temperature boiler, which is being built as a demonstration unit and to supply high-pressure steam to the works. It is of the latest power station type with Bailey water walls, an interdeck superheater and an air heater. The drums are made of a special chrome-nickel steel and alloy steel is used for the superheater and generating tubes. Various firing arrangements will be available. In an adjoining test house, we saw under steaming conditions a 550 lb. per square inch pressure water-tube marine type boiler, and a 120 lb. pressure Scotch boiler, both running on pulverised fuel.

Pulverised Fuel Firing.

In the accompanying engraving—Figs. 1 to 3—we reproduce views of the pulverised fuel boiler test house at Renfrew, showing both the high-pressure water-tube and the low-pressure cylindrical boiler, with the auxiliary plant. The visit was arranged with the main object of inspecting this particular installation, which, after a long period of preliminary tests, has now been running successfully for several months and is ready for use at sea.

The water-tube boiler—see Figs. 1 and 2—is also shown in section in Fig. 4. It was designed in accordance with a scheme drawn up at the suggestion of a number of naval architects, marine engineers, and coal owners about a year ago, which was submitted to the superintendent engineers of two of the principal British shipowning concerns. The scheme consisted of a high-pressure 2500 S.H.P. geared turbine propelling installation for a cargo steamer, with pulverised fuel boilers designed for a working pressure of 550 lb. per square inch, and a final superheated steam temperature of 750 deg. Fah. The boiler, which has been built and tested is one of two units which would be required for such an installation. For purposes of making a comparison in performance, the firm secured a standard three-furnace cylindrical saturated steam Scotch boiler built for operation at 120 lb. pressure, and the additional uptakes with air heaters, shown in Fig. 3, were added. The burners are of the standard Babcock-Lodi pattern, one

of which is shown in section in Fig. 4. The type of pulverising equipment chosen for the cylindrical boiler was a Fuller-Lehigh table type mill, which is arranged in front of the boiler. It runs at 300 r.p.m., and is driven by a standard B.T.H. 20 B.H.P. motor with a speed range of 460 to 690 r.p.m.

The water-tube boiler is of the firm's latest marine type with a superheater and air heater, but without an economiser. As our drawing shows, the combustion chamber is very roomy, having a width between the walls of 10ft. and a depth of over 7ft. The four walls are of the standard Bailey water-cooled type, with the cooling tubes covered with refractory blocks. The same type of water-cooled wall construction has been adopted for the floor of the furnace, but in this case the refractory blocks have been replaced by flat metal plates. We were able to inspect for ourselves the combustion chamber, and we found that there was good circulation of the flame with complete combustion and an almost invisible discharge of gases from the uptake.

The Babcock-Lodi burners are attached directly to the furnace front and the coal and primary air enter the burner through a central pipe and are spread by the vanes on the deflector so that a swirling motion is imparted to the entering stream. The secondary air enters through an annular space surrounding the central pipe, and it meets the stream of primary air and powdered coal in such a manner as to produce an intimate mixture at the tip of the burner with a comparatively short flame of circular cross section. The flame was such as to fill the circular furnace of the cylindrical boiler, but the short length of the furnaces did not allow the burner to operate at its fullest advantage, more perfect burning being seen in the large combustion space of the water-tube boiler.

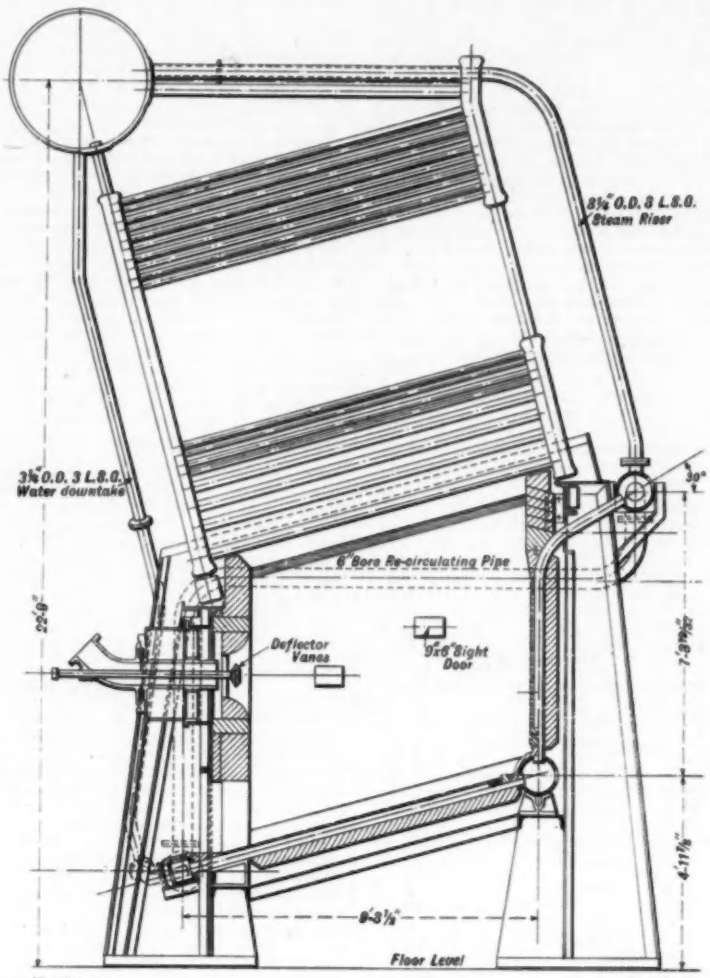


FIG. 4—HIGH-PRESSURE BOILER SHOWING BURNER AND COMBUSTION CHAMBER

As Fig. 4 shows, the lower rows of generating tubes are grouped so that any accumulation of ash and soot is prevented. They are 3½in. in outside diameter, while the upper nests are 1¾in. diameter tubes, with 4in. diameter top return tubes. The main drum is 42in. in diameter and solid drawn water boxes are used at the back of the boiler with a square section box at the front of the floor elements. The superheater is of the inter-deck type, and the boiler is designed for a safety valve load of 550 lb. per square inch and a final steam temperature of 750 deg. Fah. at the superheater outlet.

TABLE I.

No.	Item.	Scotch boiler.	Water-tube boiler.
	Duration of test, hours ..	6	48
1.	Boiler heating surface, sq. ft.	1,825	2,574
2.	Superheater heating surface	—	1,045
3.	Air heater heating surface, sq. ft.	1,625	2,400
4.	Type of mill	Fuller-Lehigh table mill	Fuller-Bonnot No. 3.
5.	Number, type and size of burners	3, Lodi, 5in.	2, Lodi, 7in.
6.	Calorific value of coal as fired, B.Th.U. per lb. ..	11,330	11,900
7.	Grading of fuel at burners through 200 mesh	Left-hand. Centre. Right-hand. 59·75 72·85 80·87	66·67
8.	Steam pressure, per sq. in., lb.	120	498
9.	Evaporation per hour, actual lb.	8,100	14,760
10.	Evaporation per hour, from and at 212 deg. Fah., lb...	9,720	20,369
11.	Evaporation per sq. ft. of boiler heating surface, from and at 212° F., lb...	5·3	7·9
12.	Evaporation per lb. of fuel, from and at 212° F., lb...	8·97	10·312
13.	Fuel fired per hour, actual, lb.	1,084	1,975
14.	Lb. of fuel per cubic ft. of combustion space	2·67	3·6
15.	Temperature—		
	(*a*) Boiler outlet, ° F. ..	867	519
	(*b*) Air heater outlet, ° F.	455	355
	(*c*) Air leaving heater, ° F.	333	324
	(*d*) At burners, ° F. ..	184	352
16.	CO_2 in waste gases, per cent.	16·46	14·4
17.	Excess air calculated from 16, per cent.	13	28
18.	Draught	1·42in.	2·9in. at fan
19.	Power used by P.F. mill and fuel fan, units per ton of coal, kWh	28	27·3
20.	Boiler efficiency on value of coal as fired, per cent. ..	76·96	84·34
21.	Deduction per cent. for auxiliaries at 18 lb. of steam per kWh, per cent.	3·0	2·93

For providing the necessary pulverised fuel for the water-tube boiler a Fuller-Bonnot ball mill is employed. It runs at the low speed of 30 r.p.m. and is driven by a 30 B.H.P. Lancashire Dynamo Company's 1450 r.p.m. motor, through worm type reducing gear. We noted that Weir feed heaters and feed pumps formed part of the auxiliary installation.

A feature of the operation of the high-pressure water-tube boiler is the flaky friable ash which is produced by the smooth water-cooled floor. Samples of ash were specially withdrawn for our inspection, and we found them to be light and non-caking, so that they could be easily and quickly removed.

The two boilers referred to were steaming very satisfactorily during the whole time of our inspection. In Table No. I., given above, we reproduce typical compara-

FIG. 5—ONE OF THE TWO "KING GEORGE V." BOILERS

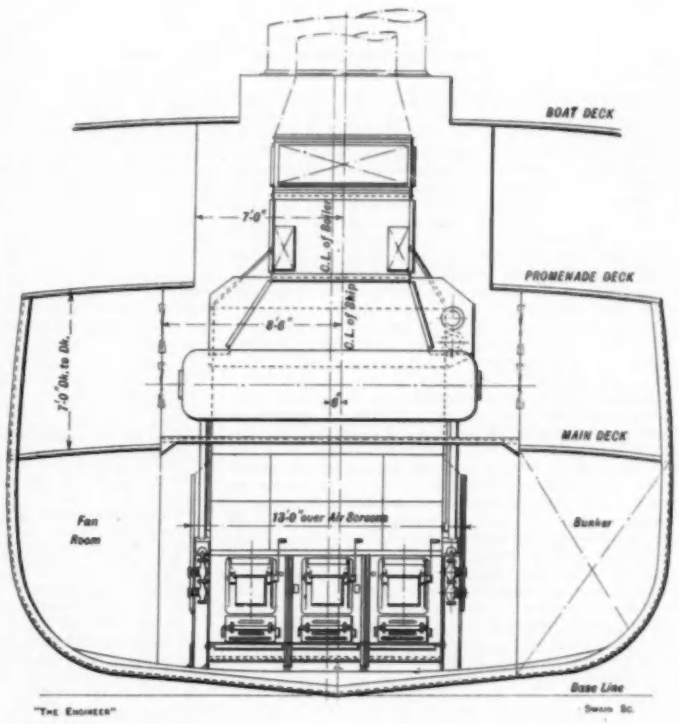


FIG. 6—ARRANGEMENT OF BOILERS IN THE "KING GEORGE V."

tive trial figures which are part of the results obtained from a continuous run of six days during which the load was varied from three-quarter load up to an overload of 42 per cent. The high efficiency of over 84 per cent. and the high evaporation of nearly 8 lb. of water per square foot of boiler heating surface, may be noted.

High-pressure Boilers on the Clyde Turbine Steamer "King George V."

After visiting the Renfrew works the party proceeded by road in saloon coaches to Gourock, and embarked on the high-pressure turbine steamer "King George V.," the steamer having been placed at the disposal of Babcock and Wilcox, Ltd., by Turbine Steamers, Ltd., and the managing owners, John Williamson and Co., of Glasgow. During the voyage from Gourock Pier through the Kyles of Bute to Tarbet on Loch Fyne, the members of the party had ample opportunity of inspecting the Parsons high-pressure geared turbine propelling machinery and the two new Babcock and Wilcox water-tube boilers, which at the beginning of 1928 were installed in the ship. We need hardly refer to the steamer herself, as a complete description of her was given in our issue of September 10th, 1926, while in the following issue we dealt with the geared turbines. The new boilers have been built for a safety valve load of 560 lb. per square inch, which is, we believe, the highest pressure at present employed in any marine boiler installed on a passenger or cargo-carrying steamer. Steam is supplied to the turbines at a pressure of 545 lb. per square inch and at a temperature of 700 deg. Fah. at the superheater outlet. In Fig. 5 we show a view of one of the two "King George V." boilers at Renfrew, while in Fig. 6 a cross section of the hull is reproduced showing the boiler in position. It may be noted that the two coal bunkers and the fan room are conveniently arranged alongside the boiler-room. With regard to the design of the boilers, the standard Babcock and Wilcox marine construction has been followed, and each boiler is eighteen sections, each of 7¼in. pitch, in width, with tubes having an overall length of 9ft. 3in. The length of the steam and water drum over its ends is 14ft., and it is a seamless forging of 3ft. external diameter. At each end of the drum there are manholes, 15in. by 11in., which give access to the interior for purposes of inspection. The lower rows of tubes are 4in. outside diameter, while the upper rows have an external diameter of 1⅜in. The heating surface of each of the two boilers is 2280 square feet, with a superheater tube surface of 780 square feet, and an air heater tube surface of 800 square feet, while the grate area of each boiler is 75·5 square feet. As previously mentioned, the steam and water drums are forgings, and in order to save as much weight as possible, the shell thickness which was necessary for the various mountings, return tubes and downtake nipples was reduced over other portions of the drum shell area in a manner as far as possible permissible with the maintenance of an approved factor of safety. The boilers were constructed in accordance with Board of Trade regulations and requirements, and before being brought into service they were submitted to a hydraulic test pressure of 875 lb. per square inch. As will seen from Fig. 6 each boiler has three firing doors. They open inwards on to a fire-grate common to the whole width of the boiler. The bars are of the Dalglish type, and have a length of 6ft. 10½in. They are of a heavy section with fluted tops.

The drawing reproduced in Fig. 7 shows a longitudinal section through the boiler-room, and indicates the lay-out of the two boilers with their superheaters, air heaters, and funnel uptakes. The arrangement is one which gives convenient space for the withdrawing of the tube sections. Between the boilers and the air heater gas inlet casings there are expansion joints, which provide for any small movement of the boilers in the ship. As will be seen from the drawing, the stokehold is completely enclosed, and the boilers work under an air pressure of about 0·85in., maintained by the forced draught fan. The fan is accommodated in one of the wing compartments, and takes its supply of cool air from the deck above, delivering it into the lower part of the boiler-room, where it spreads along the firing floor and rises to the air heater. Inlets which are controlled by hinged flaps worked from the firing floor, and operated by the engineer officer on watch. A similar control is provided for a central hatch, which can be opened at will to by-pass the air delivered by the fan to the atmosphere. The usual boiler-room staff comprises two stokers, one trimmer, along with the engineer officer on watch. The furnaces are fired according to fixed times, indicated by a clock with an audible signal, at which the firing of each furnace is carried out in rotation. During the half hour or so which we spent in the boiler-room, the firing was carried out at about 7½-minute intervals, with great regularity and without undue exertion, and the firing floor and the boiler-room in general was quite cool and pleasant. The fuel used was a friable Scotch bituminous coal, and the fires were clear and bright, even though they were rather on the thick side. Smoke was emitted from the funnels during the actual operation of firing, but between successive operations there was practically no smoke. When calling at piers or when obliged to reduce speed, the air heater inlet flaps are closed, and the centre hatch opened, so that no air is supplied to the boilers and the intensity of the fires is reduced. An advantage of the system we have described is the arrangement whereby the air after passing through the heater finds its way down the boiler casing, and thence to the underside of the fire-grates. The closed system of ventilation ensures that any air leakage is from the outside of the boiler casings to the inside, while the radiant heat loss is reduced to a minimum by means of the air casing surrounding the boiler. We were able to inspect the superheaters *in situ*, and noted that the flames passing over them were dull red and not such as to damage the tube material.

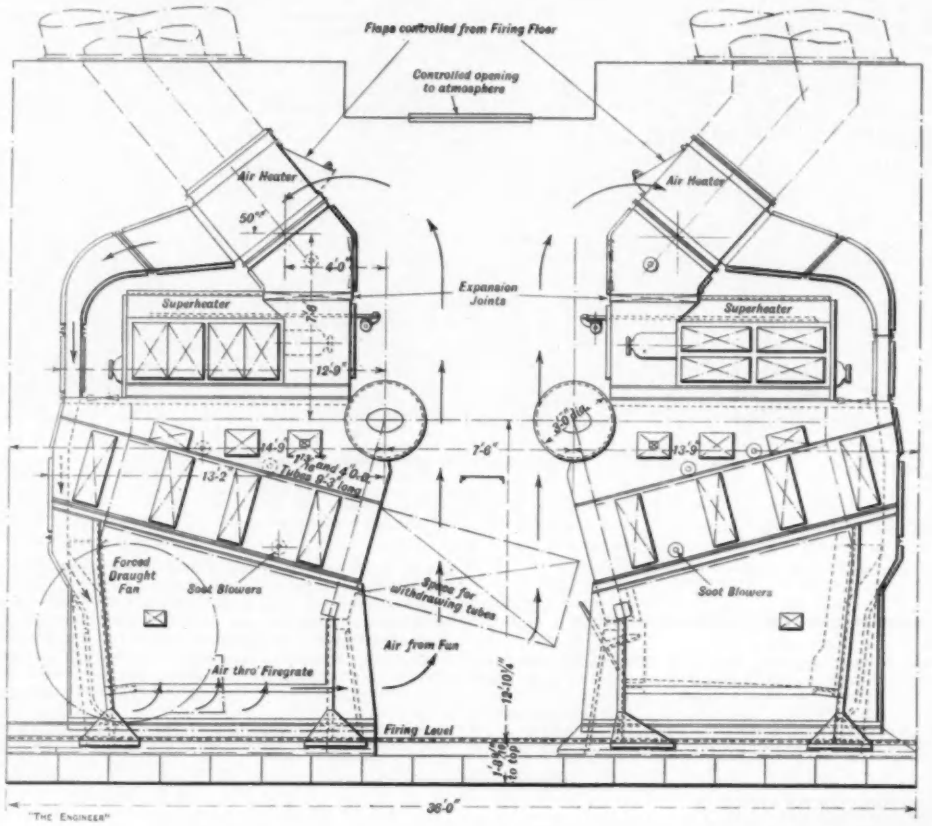


FIG. 7—ARRANGEMENT OF "KING GEORGE V." BOILERS

Table II.

Date of trial	May 8th, 1930
Duration of trial	7 hours
Boiler pressure	532 lb. per sq. in.
Superheater outlet temperature	678 deg. Fah.
Boiler-room air pressure	0·85in.
Air temperature—	
Before air heater	131 deg. Fah.
After air heater	219 deg. Fah.
Gas temperature—	
Out of boiler	655 deg. Fah.
Base of funnel	524·5 deg. Fah.
L.P. heater discharge temperature	196 deg. Fah.
Total water evaporated per hour	33,620 lb.
Coal used per hour	3,578 lb.
Coal used, "Polmaise"	13,990 B.Th.U.
Boiler efficiency	79·6 per cent.

In Table II, reproduced above, we give an abstract from a seven-hour trial made in May last. It will be noticed that a boiler efficiency of 79·6 per cent. was recorded which is slightly better than the efficiency recorded in Sir Charles Parsons' paper which was read before the North-East Coast Institution of Engineers and Shipbuilders in January, 1927, for practically similar rates of evaporation.

When the boilers were examined at the end of the 1929 season, they were found to be in good condition, with only such wear and the slight distortion of some baffles, tube supports and a few casing plates as might well have been expected under normal steaming conditions. Last winter advantage was taken during the period of laying-up to fit an additional gauge glass mounting at the centre of each drum, making three in all, there being originally one at either end. The mountings are of the latest Dewrance type, with the back illumination specially directed by louvres so as to give a clear indication of the water level by brightly illuminating the meniscus. By this means the level of water in each drum can be readily seen from the firing floor. Other improvements made to the boilers last year and during the present season include modifications to the air supply to the fuel bed at the back of the boiler, more effective means of controlling the supply of saturated steam from the de-superheater, and minor alterations to various non-pressure parts of the boilers. The steaming of the boilers in service has been easy and normal, and the steam propelling machinery has definitely established the advantages of high-pressure steam.

At the luncheon which took place on the ship, Sir Robert Dixon referred to the necessity of making full use of the fuel resources of our own country. Although, he said, pulverised fuel had recently received a little setback, owing to perhaps too extravagant claims made for it, many firms, including his own, had done careful work on the problem, and he believed that the system which the party had seen was now ready to be put forward for our marine service. It was necessary to use higher temperatures and pressures, and he felt that, for marine purposes, a pressure of 700 lb., with a fuel temperature of 750 deg. Fah., would present no difficulties to the manufacturers. Sir Charles Parsons, who replied on behalf of the guests, said that the steamer "King George V." had fully justified the courage of her builders, William Denny and Brothers, Ltd., and her owners, Turbine Steamers, Ltd. She was to be considered, he thought, a stepping stone to still higher pressures, and he expressed the hope that in a few years' time all our large liners would be operating on steam pressures of 1000 lb. or even higher pressures. On returning to Glasgow the guests met at a dinner held in the Central Hotel, over which Sir Robert Dixon presided. Sir John Biles expressed the thanks of those present for the very interesting day which they had spent, and the excellent arrangements which had been made by Mr. P. E. Rycroft for the welfare of the party.

SIXTY YEARS AGO.

The evidence tendered at the Naval Court of Inquiry, which sat between September 27th and October 4th, investigating the cause of the loss of H.M.S. "Captain," and trying the surviving members of the crew of that unfortunate ship, was summarised in a six-column leading article in our issue of October 7th, 1870. The court-martial of Mr. James May, second-class gunner, and the half-dozen men who escaped with him, was a formal part of the proceedings. The inquiry developed, in fact, very largely into an investigation of who was to blame for the disaster. There was no doubt as to its cause. The vessel had too little freeboard, was lacking in stability, and was not fitted to carry safely any press of sail in rough weather. She capsized when she was sailing, and not steaming. In his evidence Mr. Barnaby, who had succeeded Mr. E. J. Reed as chief naval constructor, revealed the fact that in February, 1870, Laird Brothers, the builders of the ship, had asked the Admiralty to incline her in order to determine her true centre of gravity. The request was not immediately granted. In fact, the vessel was not inclined until July 29th. It was found that at a mean draught of 25ft. 0½in. the vessel's centre of gravity was 2·9ft. below the water level, and that her metacentric height was 2·6ft. It would appear that there was a grave delay in calculating the stability of the ship from these figures. The calculations were not completed until August 23rd, and when they were completed the Board of Admiralty, according to Mr. Barnaby, saw nothing in them to cause it to apprehend, in the face of the reports of the officers who had tried the ship at sea, that she was in danger of capsizing. Her commander, Captain Burgoyne, V.C., was certainly left in all ignorance of the quality of his ship, as revealed by the trials. In fact, he was ordered to sea in her between the date of the trials and the completion of the calculations. The vessel left on her third and last cruise on August 4th. She was lost on the night of September 6th–7th. We asserted that two days of moderately hard work would have sufficed for any competent naval architect to have completed the calculations. The official stability curve which was finally plotted and laid before the Court of Inquiry showed that the vessel had her maximum stability at an angle of heel of 21 deg., and that at 54 deg. heel the righting moment vanished. The responsibility for the disaster resting upon the Admiralty was commonly held to be aggravated by the fact that Mr. Reed, then Chief Constructor, had read a paper before the Institution of Naval Architects in April, 1868, dealing with the stability of monitors under canvas. In it he clearly showed that a vessel having a low freeboard, such as that of the "Captain," would capsize if she were pressed by sails. The disaster, then, had been prophesied, and figures existed which very little labour would have shown definitely confirmed the prophecy. Yet the vessel was sent to sea with 500 men on her. The personalities which gathered round the controversy were numerous, but it seems clear to-day that the Admiralty's negligence was as much to blame for the disaster as the mistakes made in the design of the vessel.

The number of passenger-carrying vehicles in use on British railways at the end of 1929 was 51,243, a decrease, when compared with 1928, of 718. The seating capacity was 2,806,272, a decrease of 8851, but the average seating capacity per vehicle rose from 54·06 to 54·65. That we take to imply that four-wheeled and six-wheeled coaches have been replaced by bogie stock. Each of the last-named, of course, seats more per vehicle, but the provision of corridors therein reduces the total number of seats. The number of motor vehicles in electrical services increased by 196 and of trailer vehicles by 110; steam, petrol, &c., rail motor coaches were advanced by 38. The stock of Pullman cars rose from 204 to 229, and their seating capacity from 5758 to 6548.

Railway and Road Matters.

The Railway (Engineering) Gold Medal and the Railway (Operating) Gold Medal, given by the Railway Companies' Association for the best papers read at the Institute of Transport during the year, have been respectively awarded to Sir Henry Fowler for his contribution on "Locomotive Repairs," and Mr. Ashton Davies for his paper on "The Co-ordination of Transport."

A consequence of the closing of many of the passenger stations between York and Scarborough has been that twenty minutes has been gained in the running of some trains between those points. According to reports in the Press, attention is now being paid to the question of closing all the stations between York and Durham except the junction points of Alne, Thirsk, Northallerton, Darlington, and Ferryhill.

The Minister of Transport has found it necessary to warn local authorities, who are licensing authorities, and the proprietors of the new omnibus and motor coach services which have been started within the past few months—many of which do not appear to meet any public need—that the Traffic Commissioners, appointed under the Road Traffic Act, will not be bound to consider such services as entitled to any claim when the new system of licensing and control of public service vehicles comes into operation.

The New York, New Haven, and Hartford Railroad has placed an order for ten electric passenger locomotives with the General Electric Company of America. The engines will cost about 2,000,000 dollars, and will be the most powerful locomotives running on the New Haven line. They are to be built at Erie, Pa., for delivery next August. The new locomotives will be designed for use with either direct or alternating current, so that they may be operated between New York and New Haven, on which the current is alternating, and also in the neighbouring direct-current districts. The engines are to draw fifteen 80-ton Pullman cars up to 65 miles per hour with alternating current and up to 58 m.p.h. with direct current. They will be of 3500 H.P. and will weigh 200 tons each.

The October issue of the *Railway Magazine* is a Special 400th Number, and has a folding plate with views of "The Flying Scotsman," "Royal Scot," "Cornish Riviera" and "Golden Arrow" express trains, and ninety-six generously illustrated pages devoted mostly to special articles. Besides other articles, the Editor—since 1910—Mr. J. F. Gairns, contributes an introductory article, and Mr. G. A. Sekon—Editor from the start in 1897 to 1910—deals with "Railway Progress and Development, 1922–1930," while Mr. Cecil J. Allen writes on "British Locomotive Performance in 1897 and 1930," and Mr. C. S. Lake on "Locomotive Development, 1897–1930," covering, in the respective fields, developments not merely since 1922, but during the thirty-three years since No. 1 of the magazine appeared.

The Ministry of Transport railway statistics for the month of June were accompanied by the results for the first half of the present year. These show, when compared with those for January-June of 1929, an increase of 1·2 per cent. in the number of passenger journeys, but a decrease of 2·0 per cent. in the receipts from passengers and 1·4 per cent. in passenger traffic receipts generally. The greater number of passengers were carried, however, at an increase of only 1·4 per cent. in the passenger train mileage. The tonnage of goods fell by 3·0 per cent., which was made up of a decrease of 3·2 per cent. in general merchandise, of 2·1 per cent. in minerals and classes 1 to 6 of merchandise, and of 3·2 per cent. in coal, coke and patent fuel. The goods traffic receipts were 4·5 per cent. less. The goods train miles were reduced by 0·6 per cent., the average train load by 2·1 per cent., but the net ton miles per engine-hour advanced by 1·6 per cent.

According to the Board of Trade returns, the value of the railway material exported during the first eight months of the present year was as follows; the corresponding figures for 1929 and 1928 are added in brackets:—Locomotives, £2,400,948 (£2,220,339, £2,436,965); rails, £1,645,646 (£1,879,597, £2,430,553); carriages, £1,298,222 (£1,494,021, £1,915,084); wagons, £2,144,123 (£1,718,926, £2,271,527); wheels and axles, £251,827 (£305,094, £597,188); tires and axles £454 537 (£368,818, £401,158); chairs and metal sleepers, £518,649 (£346,161, £656,231); miscellaneous permanent way, £616,849 (£7,722,799, £957,455); total permanent way, £3,567,304 (£3,721,110, £5,126,520). The weight of the rails exported was 189,021 tons (224,668 tons, 280,679 tons), and of the chairs and metal sleepers, 55,477 tons (33,904 tons, 66,000 tons). The value of the locomotives shipped during August was £242,694, which included:—India, £68,440; the Argentine, £43,316; other countries than the Argentine in South America, £14,000; Ceylon, £11,420. The corresponding value of the rails was £117,069, which included:—South Africa, £75,192; the Argentine, £16,588; New Zealand, £5313; India, £3869; Portuguese East Africa, £3031.

The standardisation of railway signals which, as related in our Paris correspondent's letter in The Engineer of September 26th, has been decided upon by the French railways is a great compliment to our own signalling system and is the result, in part, of several visits paid to see the colour light signals here. The main innovations are the substitution of light signals for the existing varied assortment of discs and semaphores; the use of yellow instead of green for "caution" and of green in place of white for "clear." As a matter of historical interest it may be said that it is only within the last eight years or so that the yellow light was adopted by British railways and the semaphore was over fifty years old before the general managers' conference abandoned a white light for "clear" and substituted a green. Up to about 1895 some companies used green for signals at junctions only. A change that could be brought about when white for "clear" was given up was that white could then be used for the back lights of signals. The back light in a signal of which the signalman has not a front view tells that man that the lamp is burning and that the arm is "on." When the arm is put to "clear" a blinder rises, which hides the light from the signalman and so advises him that the arm is "off."

Notes and Memoranda.

The waters of Lake Michigan are easily coagulated with aluminium sulphate. While the reason for this is not definitely determined, there are indications that the waters are already saturated with soluble alumina and the addition of any amount of alum, however small, produces a precipitate.

The equipment of the Government Fuel Testing Laboratory at Ottawa includes a Babcock boiler of 677 square feet heating surface, fitted with apparatus for burning powdered fuel. The furnace has a capacity of 710 cubic feet, and is fed by an Aero pulveriser capable of dealing with 1000 lb. of coal per hour.

The world production of briquetted fuel is now about 56,000,000 metric tons a year, according to statistics compiled by the United States Bureau of Mines. Germany accounts for more than four-fifths of the world total. France and Belgium are the second and third largest producers. At present the United States contributes approximately 2 per cent. of the world production.

For the purpose of providing foundations for the power house of the new Ford factory on Dagenham marsh, a steel fence has been driven deep into the ground around this marsh, and inside the fence hundreds of pipes have been sunk to a depth of 50ft. Pumps are engaged in forcing cement at high pressure down to the bottom of the mud, where it mixes with the Thames ballast, thus making concrete. When this operation is completed the overburden will be removed, and the massive foundations will be laid.

It is reported from Havana that Monsieur Georges Claude, who has now linked up the two sections of the tube which has been sunk in the sea off Matanzas, Cuba, is very satisfied with his experiment. The tube reaches a depth of 2166ft., and the temperature of sea water obtained from that depth is 55 deg. Fah., as compared with a surface temperature of something like 82 deg. Monsieur Claude hopes that as the flow of water from the depths cools the tube, the temperature of the deep sea water may drop to 50 deg.

According to the mid-year review of the progress of water power development in Canada, by the Minister of the Interior, at the present time hydro-electric construction amounts to a greater figure than at any previous period in the history of the Dominion. Installations aggregating more than 1,680,000 H.P. are under active development from coast to coast. Many of these installations comprise the initial stages only of the respective undertakings, and when such plants have reached their ultimate designed capacities a further 2,000,000 H.P. will be added to the Dominion's total.

The Department of Scientific and Industrial Research announces the publication of the report of the Committee on Welded Containers—H.M. Stationery Office, price 1s. 3d. net. The report deals with the construction, &c., of welded vessels for storage and transport, in the liquefied state, of chlorine, sulphur dioxide, phosgene, and liquid ammonia. It discusses the conditions to be observed in the welding operations, the steel of which the containers should be made, the design of the containers and "filling ratios," and the methods of testing the vessels. Two appendices are attached to the report. In the first the results of rough handling tests, to which a number of welded vessels of different types were subjected by the railway companies, are described. In the second, the results of the subsequent examination of the vessels at the National Physical Laboratory are given.

Lithium, which is the lightest metal known, with a specific gravity of 0·59, or not much more than half that of water, is understood to be the chief element in a new aluminium alloy which is much lighter than pure aluminium and is said to be nearly as strong as steel and to be capable of standing long and heavy wear as a bearing material. The drawback to its more extended use has hitherto been the scarcity of the metal and its high cost of production, much of the lithium now produced having been extracted from German mineral springs by a process which makes its market price about £7500 a ton. The new deposits which are now being mined at Marienthal, near Windhoek, in South Africa, are reported to show the satisfactory average yield of 4·59 per cent. of lithium oxide. Already thousands of tons of ore have been mined, and the deposits in the mine now working will not be exhausted for many years.

The pyrophoric alloys may be made from metallic cerium or from a mixture of the cerium-earth metals in approximately the following proportions:—Cerium, 50 to 75 per cent.; lanthanum, neodymium, and praesodymium, 25 to 45 per cent., and iron, 0·5 to 1 per cent. The manufacture of pyrophoric alloys employs the rare-earth residues obtained as a by-product from monazite sand, and first converts them to the anhydrous chlorides. The complete dehydration, which is a rather difficult process, is essential in the preparation of the material for the subsequent steps in its manufacture. The first step is to prepare the material for electrolysis, and it has been found that to do this suitably for the continuous commercial production of metallic cerium, certain special precautions are necessary. Limited ranges of temperature are required for efficiently performing the work. The electrolyte is prepared preferably by using a solution of a mixture of chlorides of cerium and other rare-earth metals of which cerium is the chief constituent. The solution is then clarified by filtering hot or settling, and evaporated to dryness. The electrolysis is carried out in pots of cast iron high in carbon and silicon, about 8in. in diameter and 12in. to 18in. in depth. The heat is applied externally and almost wholly at the bottom of the pot. A small amount of the electrolyte is first put into the pot and nearly fused by a gas heater. The electric current is then turned on and the fusion is completed. More electrolyte is gradually added, being brought to the fusion point each time, until the pot is full. Either carbon or graphite anodes are used. The mixture of metals, when it comes from the pot, is relatively soft, and does not spark easily upon scratching. To make the commercial product, therefore, it is alloyed with about 30 per cent. of other metals, chiefly iron, and formed into small pieces to make the "flints" used in lighters, &c.

Miscellanea.

An exhibition of chemical industry is to be held in Tokyo from March 20th to May 18th, 1931.

The radio station at Chenju, near Shanghai, which is capable of communicating with Europe and America, has been completed.

The plant of the Consolidated Mining and Smelting Company of Canada, at Trail, British Colombia, is producing refined cadmium at the rate of 1½ tons a day.

The National Reconstruction Commission of China proposes to construct hydro-electric plants at Sanhsien on the Yangtze River, and at Lungmen on the Yellow River.

The Castleford, Normanton and District Mining and Technical Institute, erected on a site of 17 acres at Whitwood, was opened on September 17th by Lord Crawford and Balcarres.

The output of platinum from the Transvaal increased from 17,828 oz. in 1928 to 21,608 oz. in 1929, but the realisable value was £19,465 less, giving an average per ounce of £10,258, as against £13,525 per ounce in the previous year.

The discovery of large deposits of soluble potash in several parts of Russian Central Asia is reported. The deposits are in the districts of Kashka-Daria and Surkhan-Daria in Usbekistan. The Soviet authorities plan extensive borings in these districts for the further evaluation of the deposits.

We are pleased to hear that that veteran model maker, Mr. G. F. G. Desvignes, who is now eighty-two, was awarded a gold medal for the model which he made and exhibited at the Model Engineering Exhibition of one of his earliest high-speed steam launch engines. Some forty to fifty years ago Desvignes' launches were among the fastest vessels afloat.

Contracts have been entered into for the laying of 113 miles of 24in. high-pressure natural gas line which will form part of the proposed Texas-Chicago pipe-line to serve Chicago and the Great Lakes region. This line is being jointly constructed by a number of public utility companies. Orders for the Missouri River crossing, which will consist of 10in. lines, have already been placed.

It is announced that an American company is acquiring the leases of land in Hanover, Brunswick, and Oldenburg, with the object of drilling for oil. According to the *Berliner Zeitung-am-Mittag*, Mr. Sinclair, the American oil magnate, says that the output of the German oil wells should be sufficient to meet all Germany's requirements in the matter of oil, amounting to 400,000,000 gallons a year. He is willing, the paper adds, to purchase half a million acres and invest several million dollars.

Fifty ships left this country recently for Northern Russia by the Kara Sea Route. They are carrying iron, steel, machinery, clothing, food, &c., to the order of the Soviet Government and will return with timber, hides, wool and other Siberian products. Ice-breakers and hydroplanes will meet the convoy at the entrance to the Kara Sea and conduct them to the mouths of the Ob and the Zenesei, the two great Siberian rivers by means of which the goods will be brought to the ports from Siberia and exchanged for the English machinery and commodities.

The Londonderry County Borough Council has decided to construct the Altnaheglish Dam—forming part of the Banagher water scheme for the supply of the city—by administration under the supervision of their Engineer, Mr. Walter Criswell, M. Inst. C.E., and construction work is expected to begin within the next few weeks. The reservoir will have a capacity of 500 million gallons, the dam being constructed of concrete and having a height of 100ft. The Ministry of Labour has accepted the scheme as an unemployment scheme, and has sanctioned an expenditure on the dam and work No. 3 of a sum not exceeding £176,000.

It is reported officially that a detailed programme for the abolition of the shipping privileges heretofore enjoyed by foreigners in Chinese inland waters has been formulated by the Ministry of Communications and approved by the Central Political Council. While the Ministry of Foreign Affairs is understood to have been instructed to open negotiations with the British and Japanese Governments for the cancellation of the privileges, the Ministry of Communications has been ordered by the Council to prepare for the expansion of the Chinese shipping industry in order that the inland water routes may be efficiently served when foreign steamers are withdrawn.

The Governments of the City and County of Los Angeles have just given the order for carrying out the final improvements to Olympic Stadium, in preparation for the games of the Xth Olympiad, which are to be celebrated in it from July 30th to August 14th, 1932. The improvements now being made include increasing the seating capacity from 75,000 to 105,000 numbered seats; the construction of a promenade entirely around the Stadium; the installation of offices for committees, officials and juries, and the construction of facilities for the world press and the sports technical department. The track is being improved and will be seasoned before the coming Olympic Games. The playing field, inside the track, is of sufficient size to permit the playing of football, hockey and similar games.

The President of the Board of Trade has appointed a committee to consider the economic factors which are involved in the sale of old ships and their replacement by new vessels, and is to report whether it is desirable in the national interest that steps, which will not involve a grant from public funds, should be taken to encourage this process. A further task of the committee will be to decide, if such a course is to be recommended, what the necessary steps should be. The chairman of the committee is Mr. George A. Mitchell, and the members include Mr. R. Dennison, Sir Ernest Glover, Mr. George Latham, and Sir Frederick Lewis. The secretary of the committee is Mr. R. M. Nowell, at the Board of Trade New Public Offices, Great George-street, Westminster, S.W. 1, to whom all communications on the subject should be addressed.

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(*For description see page* 379.)

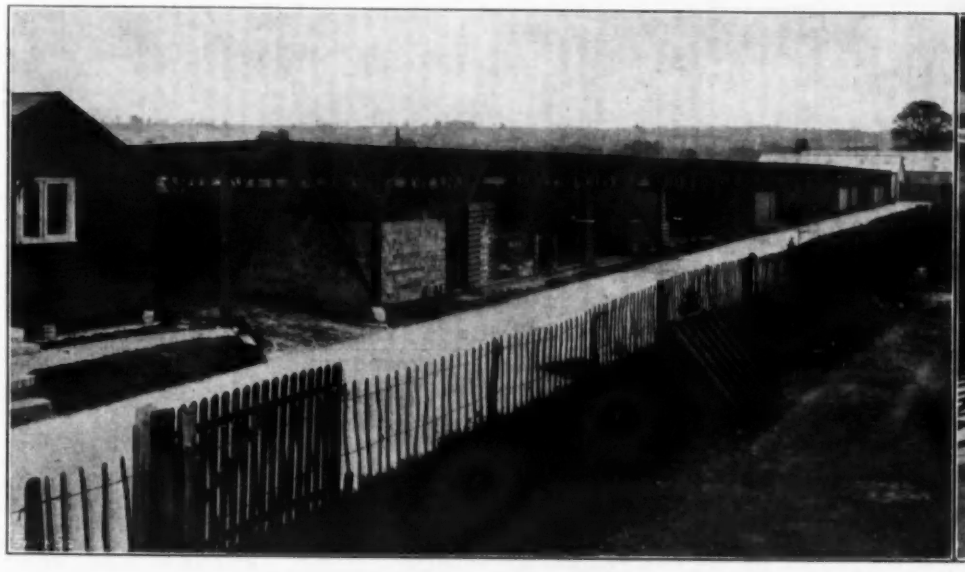

FIG. 1—BRICK STACKING SHEDS

FIG. 2—SETTING SHED WITH TRANSPORTABLE BRICK CRATES

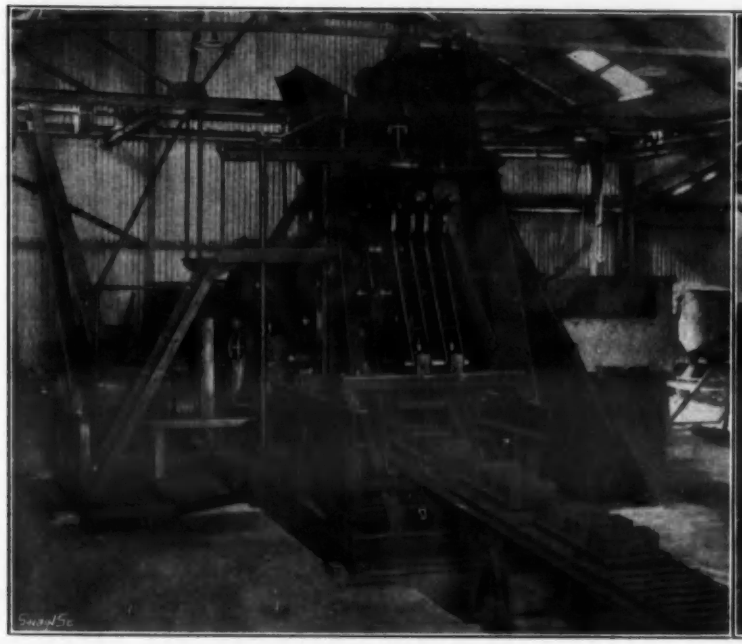

FIG. 3—NO. 2 BRICKMAKING MACHINE

FIG. 4—MACHINE HOUSE, SHOWING NO. 1 MACHINE AND MIXERS

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OCTOBER 3, 1930.

The Imperial Conference.

THE Imperial Conference assembled on Wednesday last, and from now onwards until it ends its deliberations, the eyes of the whole kingdom will be upon it. On no occasion has it been awaited with such anxiety, and at no time has a fruitful issue of its debates been so earnestly desired. The activities of former Conferences left the country relatively cold; the value of open discussion with the Dominions was recognised, but it was felt that if nothing more resulted than the cementing of the relationship between the parts of the Empire, enough would have been achieved. But this year a vital issue is before the Conference, an issue upon which the welfare of the United Kingdom depends, an issue which calls for the formulation of a new policy, and for the exercise of the highest statesmanship. It is to be deplored that the movement for the closer knitting together of the Empire should have been sullied by the intrusion of political party bias, and it will, we feel sure, be the sincere desire of all who have the future prosperity of the British Commonwealth of Nations really at heart that the deliberations of the Conference may be carried on with a single eye to the achievement of that high purpose, and that it may be free from any taint of self-seeking or prejudice.

Although the work has been broadly divided by the Prime Minister into three sections—Inter-imperial Relations, Foreign Policy and Defence, and Economic Questions—the country awaits the conclusions of the Conference on the last question with far more anxiety than it gives to the others. Two subjects—Empire Free Trade and Tariff Reform—have agitated the United Kingdom for many months, and it cannot be doubted that the discussions of the Conference will directly effect the first of these matters, and may, in consequence, have some bearing on the second. The poor condition of British industries and the growing conviction that owing to world changes our manufacturing capacity has become too large has very naturally led, on the one hand, to the desire for the creation of established markets, and, on the other, to a call for the restriction of foreign imports of products that could be made in these islands. It has been recognised for many years that the former requirement could be satisfied by a closer agreement between Great Britain and the Dominions oversea. Preferential tariffs have, unquestionably, assisted the Mother Country, but an even closer bond should not be regarded as purely visionary. The distances which separated the parts of the Empire have already been greatly reduced by the means of communications devised by scientists and engineers, and the possibility of forming a United Empire or Commonwealth of Nations is no longer remote. If Great Britain stood alone to gain by such an organisation, it could only be advanced with diffidence and with small likelihood of the support of the Dominions. But we are unwilling to believe that a means of establishing an agreement of that kind which would be of direct benefit to all is impossible. Give and take would, of course, be necessary. "If we are to embark upon a concerted plan of Empire development," says Mr. St. Clare Grondona, in his valuable compilation called "Empire Stock-taking," "it must have its basis in a spirit of compromise on all sides; that is, as between producers, manufacturers, traders, and consumers; as between political parties in each country of the Empire; and as between the various Governments in the Empire." Without that spirit of compromise no progress will be made in the economic discussions at the Conference; with it, we shall have reason to hope that the deliberations may lay the foundations of an abiding edifice of Imperial commerce.

Such are the issues with which the Conference must concern itself. They are issues into which economic and monetary questions must enter; they are the issues of the merchant, the manufacturer, and the shopkeeper. But if they are handled only in the atmosphere of the market-place, no permanent good will grow out of them. The Empire is too great for mere chaffering. It has a position of dignity to maintain in the eyes of all the nations of the earth. Let us then pray that the traditions of great statesmanship which have been handed down by successive generations of Britons in whatever part of the world they may inhabit may shine through the deliberations of the Conference, that its agreements may be reached without pettifogging, and that no thought or desire unworthy of a great people may hinder the full achievement of the purpose of the Conference, and the attainment by the Empire as a whole of the prosperity and contentment that it seeks.

The Measurement of Noise.

IN 1928 a sub-committee of the Aeronautical Research Committee was appointed to study aircraft noise. The terms of reference charged this sub-committee to arrange a programme of research relating to the reduction of noise, not only as it manifests itself inside the cabins of passenger-carrying machines, but as it is heard on the ground from a machine passing overhead. It is evident that the subject is of considerable and growing importance. To the passengers in a civil machine the noise experienced is a distressing accompaniment of flight. In the neighbourhood of a big aerodrome, civil or military, the inhabitants on the ground may with justice complain of the noise produced by machines alighting or taking off. In military aeroplanes noise is objectionable, not only because it provides an outstanding means for the easy detection and location of a machine by an enemy, but because of the very tiring effect which it has upon the crew. The subject is aeronautical in its primary significance, but it is clear that the work of the committee may, by the time it is completed, be found to have a wide interest and be applicable, in some of its aspects, to that pressing problem, the elimination or reduction of the general mechanical noises which inflict themselves upon our daily lives. In an aeroplane the production of mechanical noise reaches a degree which for magnitude and concentration is perhaps unsurpassed by the worst that any other familiar unit of machinery can produce. But in directing its attention to the reduction of aircraft noise, the sub-committee has a field before it the exploration of which, even with the most strict adherence to the terms of reference, cannot fail to be of benefit in other directions.

The amount of energy present in the superposed trains of sound waves which constitute a noise is in most cases, even if the noise is a loud one, surprisingly small. Like our other sensory organs, the ear is sensitive to the reception of an extremely minute amount of energy. It follows, therefore, that the energy wasted in noise by a machine would, if the

machine were made silent, add very little to its efficiency. Noise in mechanical appliances is in many cases evidence of the existence of conditions implying inefficiency, but *per se* it is not in general a source of serious loss of energy. It may be produced as the result of a misfit among the parts of the machine or be the product of irregular engagement. The damage and loss which may arise from these conditions are out of all proportion with the amount of energy involved in the noise by which their existence is indicated. So, too, is the energy of a noise wholly disproportionate to the distress and loss of personal efficiency which the noise may cause in those on whom it is inflicted. Here we have a very grave result of mechanical noise, a result the gravity of which is increased by the fact that so far no means of measuring it have been evolved. Everyone knows from personal experience the fatigue and loss of efficiency produced by noisy working conditions, but beyond a vague knowledge that the fatigue and loss are great we have no information of their magnitude. These are questions into which the Aircraft Noise Sub-Committee will probably not deem it necessary to go in fulfilment of its terms of reference. It is, however, fairly certain from a preliminary account of its work published in the Aeronautical Research Committee's report for 1929–30 that its activities are leading it to explore the fundamentals of noise production in a manner which will enable others to continue and extend its studies in a general direction. Where, as in an aeroplane, there are several simultaneous sources of noise it is obviously necessary to determine the nature and degree of each separately. To come to grips with the subject some means must be provided to measure the magnitude of the noise arising from each separate source. To that end the sub-committee has produced an instrument, apparently successful, for measuring noises. The device is of the audiometer type. A telephone note applied to one ear of the observer is adjusted in loudness until it is just drowned by the noise received on the other ear. The instrument has been calibrated in absolute acoustical units, namely, in "decibels," of which 130 cover the range of sensation of the ear. Some preliminary results obtained with this instrument or otherwise may be noted. It has been found that the exhaust from an aero-engine is responsible for nearly as much noise as the airscrew, and that a reduction of the exhaust noise is not necessarily accompanied by a proportionate increase in back pressure. Investigating airscrew noises, the sub-committee found that they were intimately associated with high tip speeds, an increase of about 10 decibels accompanying an increase in the tip speed by 100ft. per second. For the same power absorption blades of thin conventional section were 10 decibels quieter than blades of thick section. As an indication of the gross conditions of noise encountered in an aeroplane, it is worthy of remark that a note of standard loudness which in normal daytime silence could be heard at a distance of several hundred feet could, in the neighbourhood of an airscrew, be heard only at a distance of a few inches. Inside the cabin of the aeroplane the same note could be heard at a distance of a few feet, whereas in the corridor of an express train the distance of audibility was 100ft.

The measurement of noise provides a field of study in which, for the present, we have to rely more upon personal impressions than upon scientific observations. Physiology as well as physics enters into the question. The sub-committee has made a good beginning with its calibrated audiometer. Such an instrument by itself is not, however, sufficient for a complete investigation of the subject. In spite of its calibration in absolute acoustical units, its principle is essentially arbitrary, but it is reported that, using it, independent observers agree substantially in their results. It is quite possible that this agreement may reflect the roughness rather than the refinement with which the instrument works. Its action appears to be based on an assumption which could not be admitted in connection with most physical measuring instruments. It assumes equal acuity of hearing in the observer's ears, and we await with interest further information on the steps taken by the Committee to circumvent that difficulty. The audiometer as a means of studying noise is limited in another fundamental direction. It measures merely the loudness of the noise—that is to say, the energy in the superposed trains of sound waves composing it. The reaction of human beings to noise is not, however, solely determined by its loudness. It is largely psychological. A prolonged continuous low hum can be as fatiguing as a loud intermittent clash. If it is less distressful it is only so because we associate the hum of machinery with regularity of action, and an intermittent clash or knock with irregularity. The measurement of loudness is the first and most obvious step to arrange in the scientific study of noise and its repression. It is, however, only one of several steps. Before the problem is solved it will be found necessary to enter into many questions of a physical, physiological, and psychological nature.

Obituary.

SIR JOHN NORTON-GRIFFITHS.

Following closely on the notification to the Egyptian Ministry of Public Works—to which we referred in our issue of last week—by the contractors who had been engaged on the work of raising the height of the Assuan Dam, that they had decided to suspend operations, comes the news that the Governing Director of the firm, Lieut.-Col. Sir John Norton-Griffiths, D.S.O., met his death in tragic circumstances on Saturday morning last, September 27th. He had been staying at San Stefano, a seaside resort near Alexandria, and early in the morning he went out in a surf boat, returning to the shore after a time, and then again putting to sea. It was subsequently noticed that the small craft appeared to be untenanted, and on a boat being sent out to investigate the matter, Sir John's body, with a bullet wound in the head, was found, lifeless, floating in the sea.

John Griffiths—his name, originally, before he assumed the additional name of Norton—who was the son of the late Mr. John Griffiths, of Brecon, was born in Somerset on July 13th, 1871. His life may be truly described as one long adventure. Quite early he developed a restless desire to see the world, and the longing to go about eventually became so great that, at the age of seventeen, he signed on as seaman before the mast on a wind-jammer bound for Australia. Exactly how long he remained in that country we are not certain, but he occupied his time, largely, in obtaining engineering, excavating and tunnelling experience in remote mining areas, incidentally acquiring that valuable attribute, the ability to control bodies of men, all of which proved subsequently invaluable to him. Then he travelled to South Africa, where he obtained further engineering experience and practised as an engineer.

His restless spirit, however, prompted him, on the outbreak of the Matabele war in 1896, to take part in that campaign, during which he commanded a body of Scouts. Again, when the second Boer war came in 1899, he once more volunteered for active service. He was, first, with Brabant's Second Division, in the South African Field Force, and later became Captain and Adjutant of Lord Roberts' Bodyguard, on the Headquarters Staff. He was present at several engagements, among them the Modder River and Paardeberg, was thrice mentioned in despatches, and was awarded two medals and clasps.

On the conclusion of peace he set himself to build up a business as an engineering contractor, and among the other works which he successfully carried out was the first section of the Benguela Railway—100 miles or so in length—which entailed the crossing of a range of mountains at an elevation of some 6000ft. That was in 1905. He also carried out works in America. In this country he founded the firm of Griffiths and Co., Ltd., public works contractors, and was responsible for many important engineering constructions.

These business activities, however, were not sufficient to provide adequate outlet for his superabundant energies. He had, as an over-mastering ambition, the desire to emulate Cecil Rhodes and become an "Empire Builder." He was a patriot to the core, and he had the gift of being able to fire others with enthusiasm similar to his own. As a means of achieving his Imperial ideas he decided to enter Parliament, and in 1909 was elected Conservative member for Wednesbury. Among his colleagues in the House of Commons he earned the nickname of "Empire Jack," so great was his zeal for the ends which he had at heart and so tireless was he in advocating the cause of the Empire. He represented Wednesbury until 1918 and from the latter year till 1924 was Member for Wandsworth Central. While representing the first-named constituency he founded the Imperial League of Wednesbury, the aim of which was to assist emigration to various parts of the Empire. An idea of his own was to found an entirely new town in Canada, and he made a special visit to that country for the purpose.

How intimately the soldier in him was intermingled with the engineer and the patriot was again demonstrated in the Great War. He got into touch with Lord Kitchener, and from him obtained permission to provide additional cavalry on condition that he did so without spending public money. Accordingly, he raised and equipped the 2nd King Edward's Horse, at his own expense. His services with the Forces won for him commendation on every hand, and he was eventually attached to the staff of the Engineer-in-Chief, General Headquarters, so that he might start and organise tunnelling companies of the Royal Engineers. To him was a very large extent—if not entirely—due the planning and carrying out of the tunnelling operations under the Messines Ridge, which led to the successful destruction of that vantage point of the enemy, and which was among the most gigantic works of the kind ever attempted. For his services he was again mentioned three times in despatches, was awarded the D.S.O., and was promoted temporary Lieut.-Colonel.

Colonel Griffiths was not destined to serve for the full length of the War on the Western front. Possibly because of the brilliance of his success at Messines, he was chosen as General Service Officer (First Grade) to proceed on a special mission to Roumania. It was given out that his mission was concerned with corn and oil stores, but in reality it was to effect the destruction of the Roumanian oil wells before they—as it had become evident they must—fell into the hands of the Germans. We have not space, here, to go into detail as to the thorough methods which he employed to achieve the desired aim, not only of wrecking the oil works, but in destroying standing crops; but so far-reaching were they that the enemy, when he arrived, found himself unable to obtain those supplies of oil and foodstuffs on which he had fully counted and of which he was in sore need. It was computed that the intrinsic or replacement value of the damage done was no less a sum than £56,000,000, and it has since been said of the achievement—in effecting which he many times risked his life—that, actually, it was of as great service to the Allied Armies as though they had won a great victory in the field. The feat earned for him a second nickname, that of "Angel of Destruction." It also won for him a knighthood, as he was created K.C.B. in 1917. Five years later he was made a baronet and he then, by deed poll, assumed the name of Norton-Griffiths.

What might well have been the greatest triumph of his engineering career, but which was, in fact, his greatest disaster, was the contract for the raising of the Assuan Dam. As originally built, that great Dam across the Nile was 120ft. in height. It was subsequently raised 23ft., and as the result of a favourable Report of an International Commission—with which Report we dealt at some length when it was made public—the Egyptian Government decided in February, 1929, to raise the structure by another 23ft. The contract to carry out the work was entered into with Sir John Norton-Griffiths and Co., Ltd., as the company had come to be called, and the firm, until the notification above referred to was handed in, had been occupied in constructional operations. We have not, as yet, sufficient information regarding the rights and wrongs of the matter to enter into a discussion of them nor to seek the cause or causes of the friction which had undoubtedly arisen between the Egyptian authorities and the contractors; nor is this the place to discuss other aspects of the contract, which must have caused Sir John grave anxiety. The melancholy fact remains, however, that the worry and trouble entailed must—since the medical testimony is reported to be that the bullet wound was self-inflicted—have temporarily unhinged Sir John's mind and led him to take his own life. Thus has passed a man who was, in many ways, great and whose loss will be deeply felt and sorely mourned by a very large circle of friends.

In addition to the honours of which mention has already been made, Sir John was, for his services in that country, made a Commander of the Grand Star of Roumania. He was also an Officer of the Légion d'Honneur, and a Member of the Order of St. Vladimir. He was a member of the Institute of Mining and Metallurgy, and a Fellow of the Geological Society. Besides being Governing Director of Norton-Griffiths and Co., Ltd., he was also senior partner in the firm of Norton-Griffiths, Bruce, Marriott and Co.

BOOKS RECEIVED.

Seeing by Wireless (Television). By Ralph Stranger. London: George Newnes, Ltd., 8–11, Southampton-street, W.C. 2. Price 1s. net.

The Institute of Chemistry of Great Britain and Ireland: Journal and Proceedings, 1930. Part IV. London: Published by the Institute, 30, Russell-square, W.C. 1.

A Micrometer of High Sensitivity. By E. Ower, B.Sc., A.C.G.I. Being Reports and Memoranda No. 1308 (Ae 448) of the Aeronautical Research Committee of the Air Ministry. London: H.M. Stationery Office. 1930. Price 9d. net.

Rapid Methods for the Analysis of Special Steels, Steel-making Alloys, their Ores, Graphites, and Bearing Metals. Fourth edition. By C. Morris Johnson, Ph.B., Ph.M. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 37s. 6d. net.

Wind Tunnel Tests on Gloster and Supermarine Wing Radiators. By Dr. R. G. Harris, L. E. Caygill, A.M.I.M.E., and R. A. Fairthorne, being Reports and Memoranda No. 1311 (Ae. 450) of the Aeronautical Research Committee of the Air Ministry. Published by H.M. Stationary Office. 1930. Price 9d.

The Stresses in a Radially-Spoked Wire Wheel under Loads Applied to the Rim. By Professor A. J. Sutton Pippard, M.B.E., D.Sc., M. Inst. C.E., and W. E. Francis, M.Sc. Being Reports and Memoranda No. 1302 (Ae 445) of the Aeronautical Research Committee of the Air Ministry. London: H.M. Stationery Office. 1930. Price 2s. 3d. net.

The Institute of Fuel.

IN view of the importance of the economical use of fuel in large power stations, and the fact that considerable controversy has arisen concerning the respective merits of pulverised coal plant and mechanical stokers, arrangements were recently made by the Institute of Fuel for some of its members to inspect London plants of both types in order that they might ascertain at first hand what is being done along these lines. On Thursday, September 25th, a party composed of the Institute's members was conveyed by steamer to the County of London Electric Supply Company's power station at Barking, to the Fuel Research Station at Greenwich, and finally to the two Deptford stations of the London Power Company, whilst in the evening a meeting was held at the Institution of Electrical Engineers, when members of the staffs of the stations visited replied to questions submitted regarding the plants seen during the day.

The excursion proved highly interesting and instructive, but what general conclusion was arrived at concerning the relative merits of pulverised coal plant and mechanical stokers we do not know. Of the speakers who took part in the discussion which followed the visits, only one, namely, Mr. R. A. Chattock, expressed an opinion on the matter. At Birmingham, he explained, they turned to pulverised coal because, in the Midlands, coal was not so good as it was elsewhere. Good quality coal could be burnt very efficiently on mechanical stokers, which, however, were less satisfactory when it came to dealing with coal having a calorific value of 10,000 B.Th.U. or less. With pulverising equipment it was possible to burn poor quality coal and to get the best out of it. Pulverised coal had come to stay, for even where it was possible to obtain good quality coal it was possible to obtain higher boiler efficiencies. Referring to the dust trouble with pulverised coal, Mr. Chattock said that most engineers were employing the cyclone dust catchers, but a single cyclone did not catch enough of the grit and dust. He had tried connecting two in series, and had caught about 70 per cent. of the dust, the remaining 30 per cent. being of very fine texture. The Barking station did not represent the latest and best practice. There was not enough daylight, and there was too much dirt and dust. The members of the Institute should not attach too much importance to Barking, as it was not a modern example from the point of view of pulverised coal. At Hams Hall, where 50,000 kilowatts had been installed, the coal consumption was 1·56 lb. per B.Th.U., the coal having a calorific value of 10,028 B.Th.U. The thermal efficiency was 21·27 per cent. and the total works cost 0·135d. per unit.

Replying to a question put by Mr. Chattock as to whether the practice of drying the coal by flue gases in the mill had proved satisfactory, one of the Barking engineers, Mr. J. A. Vice, said that the practice had given no trouble. During the past six months the moisture content of the coal had never been less than 9 per cent. or more than 11 per cent., which was reduced to from 2 per cent. to 4 per cent. No definite conclusion had been arrived at at Barking as to whether pulverised coal plant was better than mechanical stokers. As regarded reheating the steam on one of the turbo generator sets, however, it had been found that whilst the turbine efficiency was increased by about 3 per cent., to a large extent that gain in efficiency was lost in the boiler. The reheating principle was adopted as an experiment, and with the existing arrangements it has not proved particularly satisfactory.

Mr. A. H. Ellis, of the Deptford stations, explained that with the latest types of travelling grate and retort stokers, the Deptford boilers showed an efficiency of about 88 per cent. on test with coal having a calorific value of 10,500 B.Th.U. At Deptford there were considerable variations in the demand for steam, owing to the traction load, but the mechanical stokers in use met the demand admirably. From the point of view of repairs and maintenance, there was very little to choose between the two types of stokers. The members of the Institute, Mr. Ellis said, had seen the two stations in operation, each working with a load of about 50,000 kilowatts, and they had no doubt observed that there was very little grit and dust. The conditions were quite normal, and he had in his possession a letter from the Medical Officer of Health congratulating the Deptford engineers on the satisfactory state of affairs and classing the Deptford stations as model stations. The company, however, was still dissatisfied with the results and had patented a method for further treatment of the flue gases. The thermal efficiency of the Deptford West station, Mr. Ellis explained, was 22 per cent.

In dealing with the grit problem, Dr. C. H. Lander, of the Fuel Research Station, explained that the trouble could be eliminated entirely, but at cost. Mr. Chattock had mentioned that by connecting two cyclones in series he had reduced the trouble, and it was conceivable that if he connected more cyclones in series he might overcome the trouble altogether. The cost of the scheme had, however, to be considered. It had been suggested that research work should be carried out on grit and sulphur. A little had been done, but they wanted a large boiler and a large stack. He did not think that research would result in much improvement. The very fine stuff was not likely to prove very troublesome.

BARKING POWER STATION.

The boiler-house plant at Barking consists of two installations of boiler units in separate boiler-houses at right angles to the turbine-room building. The No. 1 boiler-house, which was the first section to be completed and to be put into service, contains twelve boiler units and four combined steam reheater and boiler units, but two of the latter have not been fitted with steam reheating equipment and are at present operated as ordinary boiler units. Six of the boiler units and the two completed reheater boiler units are of Babcock and Wilcox design, whilst the other eight are of the Yarrow type. Each boiler consists of a steam generator with superheater with its own mechanical draught equipment, consisting of forced and induced draught fans. No economisers are incorporated in the design of the plant in No. 1 boiler-house. The working pressure is 375 lb. per square inch, and the steam is superheated to a total temperature of 725 deg. Fah. from feed water supplied at 250 deg. Fah.

The two completed reheater boiler units were designed to operate in conjunction with No. 1 turbo-alternator, the primary object being to take the exhaust of the turbine high-pressure cylinder and reheat this steam to the initial turbine inlet steam temperature before passing it to the turbine intermediate pressure cylinder. Each reheater unit consists of a combination of reheater-boiler, superheater and air heater, and the steam generated and superheated in the boiler section is passed direct to the main steam range. With the exception of the two Yarrow type incomplete reheaters, each boiler unit is equipped with two mechanical stokers, and all gas passes through each unit are equipped with the requisite number of soot blowers. All the mechanical draught equipment is symmetrically grouped on the roof around each of the four stacks, each of which receives the gas discharge from four units.

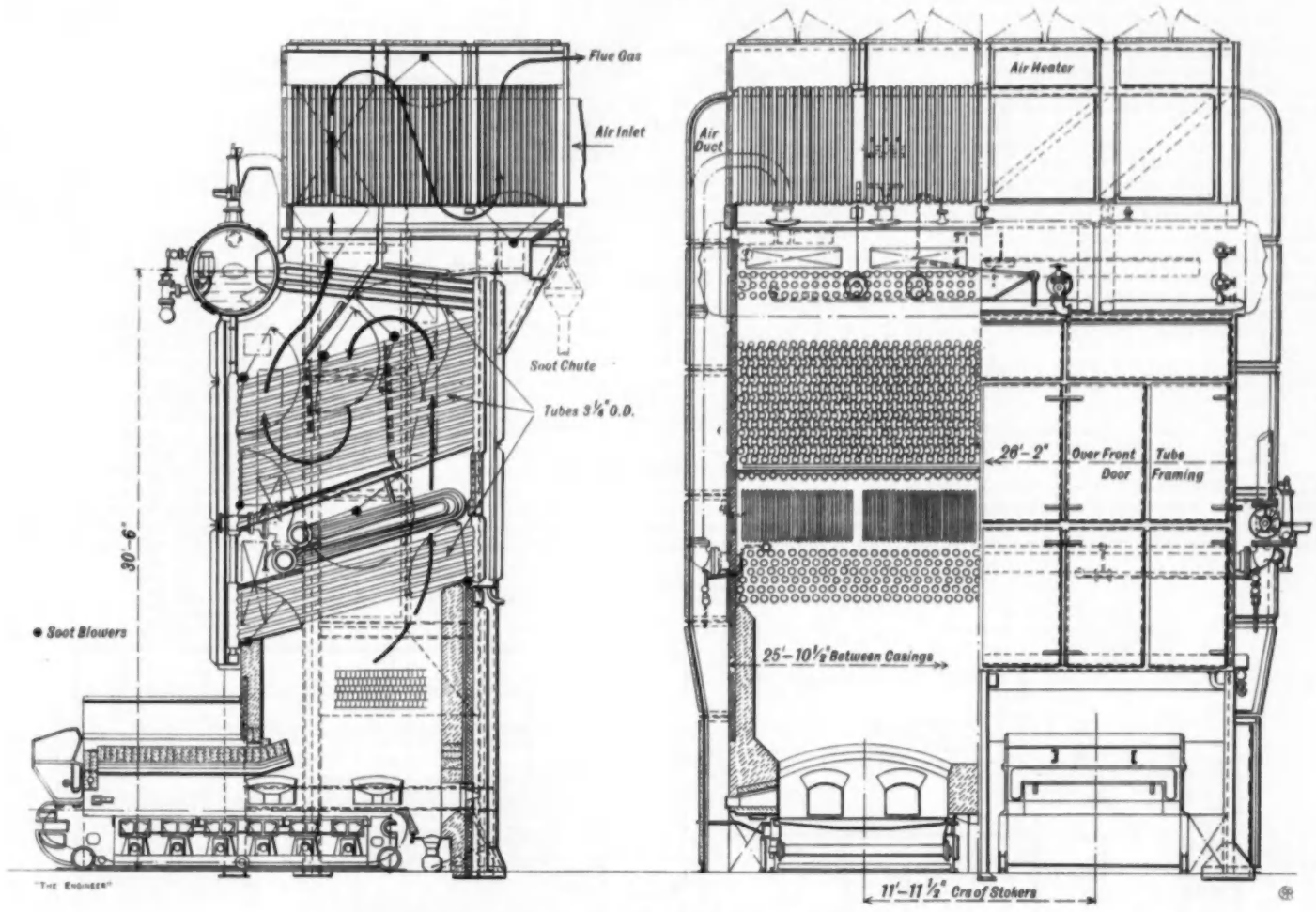


FIG. 1—BABCOCK BOILER FITTED WITH SUPERHEATER AND AIR HEATER

Each of the Babcock units shown in Fig. 1 is designed for a normal evaporation of 68,000 lb. per hour under the steam and feed-water temperature conditions mentioned, and has an overload capacity of 85,000 lb. per hour. The principal particulars of these Babcock boilers are :—

	Square feet.
Boiler heating surface	12,028
Superheater heating surface	2,309
Air heater heating surface	17,000

Chain grate stokers : Two per unit, each 9ft. wide by 16ft. long and having a total grate area of 288 square feet.

The boilers are of cross-drum type, with vertical headers carried on a structure under the front and rear headers, the superheaters consisting of circular

headers connected by tubes, through which the steam makes five passes, these being arranged in the gas pass of each unit immediately above the sixth row of lower water tubes.

The tubular type air heaters are carried on top of the boiler and are arranged so that the air passes around the outside of the tubes, whilst the gases pass through the tubes. Each air heater is designed to reduce the final temperature of the flue gas at normal loading to a value not exceeding 325 deg. Fah. From the air heaters the hot air is carried to the stokers by means of ducts arranged on the side of the boiler casing, each duct being fitted with a damper controlled from the operating floor.

There are two Babcock and Wilcox chain grate stokers for each unit. Originally they were of the compartment type, but conditions of operation peculiar to the station necessitated considerable modifications. Each stoker has had a number of compartments removed and is now totally enclosed, and provision is made on the front closing plates for inspection of the grate surface and removal of riddlings, &c. Another alteration consists in re-circulating, with the air for combustion, a certain proportion of the inert flue gases, which are taken from the final gas discharge by a fan and delivered to the incoming air. Arrangements are also made for the controlled admission of overhead air. A motor drives each stoker unit independently through gearing in which an epicyclic train is incorporated, and which, in conjunction with a brake and variable cam, provides a wide range of control, giving eight different grate speeds.

From overhead bunkers coal is supplied to the hoppers of each stoker by a circular chute, which automatically traverses the width of the hopper, the traversing gear being operated by a scroll shaft on the front of the stoker. For each unit there are twenty valves in head-type Diamond soot blowers, fourteen for the boiler and superheater gas passes and six for the interior of the air heater tubes. Cope's regulators are used for regulating the feed water.

Each of the six main Yarrow boiler units is designed for a normal evaporation of 68,000 lb. per hour, when working under the steam and water conditions mentioned, and each unit is capable of maintaining an overload of 50 per cent. The principal particulars of these boilers are :—

	Square feet.
Boiler heating surface	11,700
Superheater heating surface	2,600
Air heater heating surface	17,000
Travelling grate stokers : Two per unit, each 9ft. 6in wide by 17ft. 6in. long, giving a total grate area of 332·5 square feet.	

The general arrangement of one of these units is shown in Fig. 2, from which it will be seen that the boiler consists of a main steam drum connected by banks of generating tubes to three lower drums, and single drum baffled internally in such a manner that the steam makes three passes through the tubes between entry and exit. Tubular-type air heaters

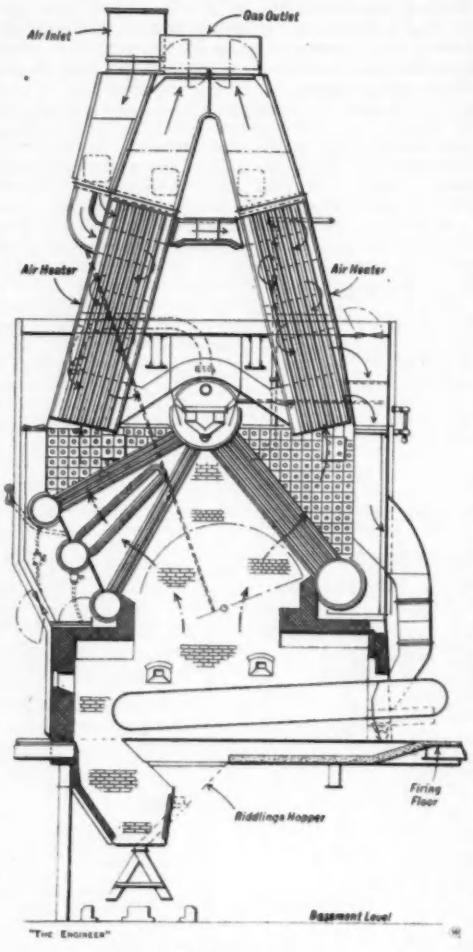


FIG. 2—YARROW BOILER

are arranged on the top of the two gas outlets from each boiler, but each pair operates as one unit, a division plate being provided at the inlet so that one half of the air passes through each leg of the heater. As in the case of the Babcock air heaters, the flue gas passes through the tubes with the air on the outside. Each air heater is designed to reduce the final temperature of the flue gas at normal load to a value not exceeding 325 deg. Fah. The gas passing through the front and rear tube banks of each boiler unit and therefore through each leg of the air heater is controlled by dampers fitted in the gas exit leg from each heater and is controlled from the operating floor. By means of ducts the heated air is taken down each side of the unit to the wind boxes of each stoker and dampers are provided near the floor level for control. Each unit is equipped with two stokers of the Underfeed Stoker Company's L type.

The combustion air enters a wind box built integral with the stoker and carried between the top and bottom grate surfaces. From this chamber the air to the fire bed is regulated by means of dampers or valves controlling the whole area of the fire bed.

All the grates of the six main Yarrow units are driven by a line shafting under the operating floor, and the gearing on each grate to which the line shafting is coupled by worm gearing is arranged to give eight grate speeds. Coal is supplied from overhead bunkers to the stoker hoppers in a manner similar to that employed on the Babcock and Wilcox units. Each unit has two Parry soot blowers, which, when in operation, project into the combustion chamber and sweep an arc covering the entire heating surface, sufficient velocity being provided effectively to clean the straight gas passes.

The four combined boiler and steam reheater units consist of two of Babcock and Wilcox design and two of Yarrow design, but the two latter are not completed for reheating and are operated when required as ordinary steam generating units.

The general arrangement of one of the Babcock and Wilcox reheater units is shown in Fig. 3. Contrary to the usual Babcock and Wilcox practice, they are designed with only one gas pass. The steam reheating section is arranged in one side of the unit, between the fifth row of lower tubes and the return tubes at the top of the unit, and this section is separated from the boiler portion by a dividing wall arranged vertically. Above this the gases from both sections become common, and enter a tubular type air heater at the rear of the unit. Two dampers control the gas quantity from each half of the unit. The damper on the boiler section is hand operated, but that over the reheater section automatically controls the temperature of the reheated steam to a value of 725 deg. Fah. The reheater section is designed to deal with 165,000 lb. of steam per hour at normal load and to reheat this steam from a temperature between 350 deg. Fah. and 450 deg. to 725 deg. Fah., and each reheater section is capable of sustaining an overload of 25 per cent. The boiler section of each unit is designed to give a normal evaporation of 44,000 lb. of steam per hour under the previously mentioned conditions and this section is capable of sustaining an overload of 25 per cent.

The reheater consists of four horizontal drums

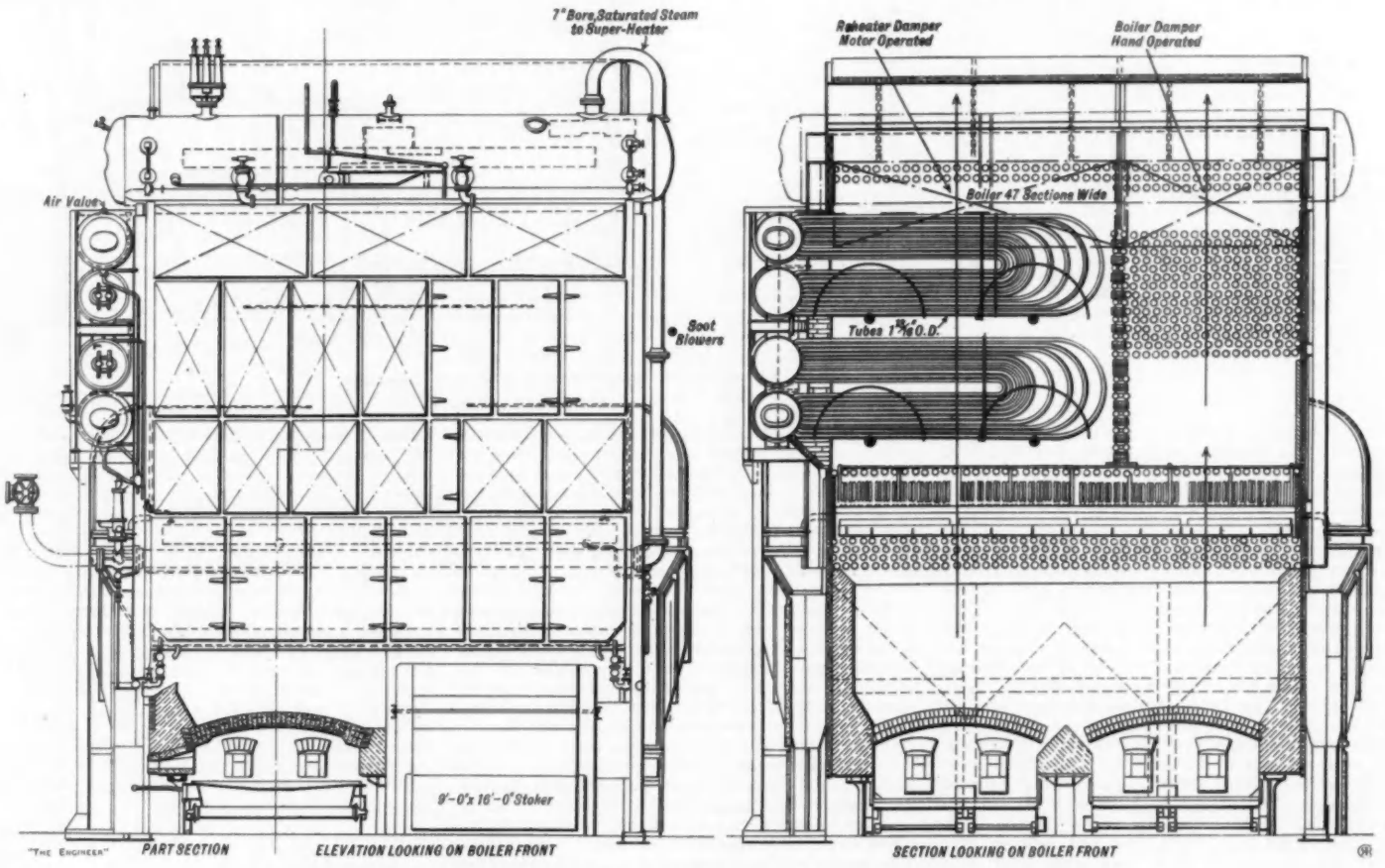


FIG. 3—BABCOCK BOILER FITTED WITH SUPERHEATER, RE-HEATER AND AIR HEATER

the unit is so arranged in its setting that two straight gas passes are provided, one by way of the front bank of tubes and one by way of the two rear banks of tubes. The superheater, which is placed between the two rear generating tube banks, consists of a arranged along the side of the unit and are coupled in series by a bank of tubes in the gas pass of the unit. Steam from the turbine high-pressure cylinder exhaust enters the upper drum and passes downwards through the tubes to the lower drum and thence to the turbine

intermediate cylinder inlet. On the boiler section of the unit the superheater is arranged in the space above the fourth row of lower tubes and is of similar design to the other Babcock and Wilcox superheaters.

The principal particulars of these reheater units are :

	Square feet.
Reheater heating surface	14,000
Boiler heating surface	6,840
Superheater heating surface	1,680
Air heater heating surface	17,000

There are two chain grate stokers for each unit similar to those on the other Babcock and Wilcox boilers.

The steam generating plant in No. 2 boiler-house consists of ten pulverised fuel fired boilers. Each unit has a rated capacity of 135,000 lb. of steam per hour at normal load, with an overload capacity of 187,500 lb. of steam per hour. The complete installation of buildings, boilers, coal preparation plant, and all auxiliaries was supplied and erected by International Combustion, Ltd., and incorporates the well-known Lopulco system. Each boiler unit is a combination of boiler, superheater, economiser, air heater and combustion chamber. The combustion chamber rear and side walls are cooled by Murray fin tubes with a tubular water screen protecting the bottom. The

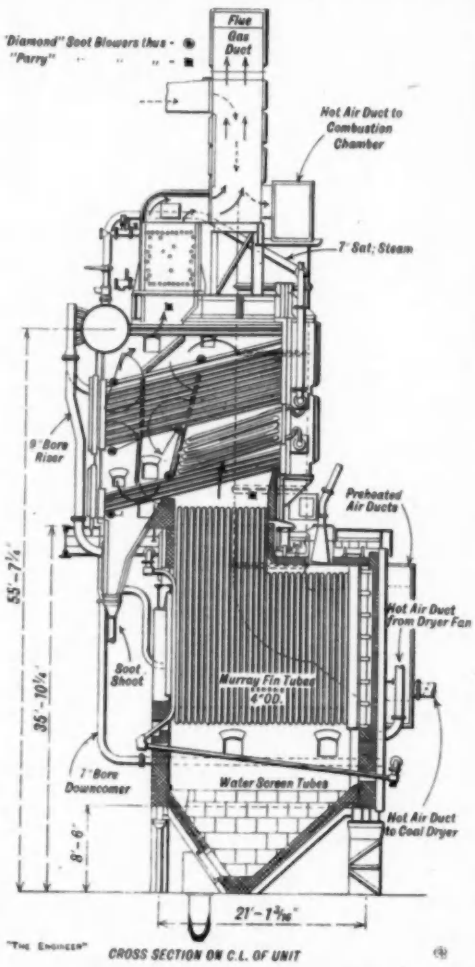


FIG. 4—PULVERISED FUEL BOILER

mechanical draught equipment consists of two induced draught fans and one forced draught fan, each separately driven by a 415-volt alternating-current motor. The design of each unit provides for a working steam pressure of 375 lb. per square inch gauge at a total superheated temperature of 725 deg. Fah. from feed water at a temperature of 260 deg. Fah.

The ten units, with the necessary combination of coal preparation plant, are arranged in two rows along the length of the boiler-room and all operating floors are arranged to face the windows of the building. Two lines of raw coal bunkers, each line serving five coal preparation plant units, are arranged on the boiler-house roof. From here the coals fall to the mills of the preparation plant and, in addition to being pulverised, all drying is also carried out in the mill system by means of flue gas bled from the end of the first gas pass of the boiler units. All mechanical draught equipment and grit collectors are carried on the boiler-house roof under cover. The chimneys, of which there are five, are also carried on the roof structure, each chimney serving two boilers.

The general arrangement of a pulverised fuel fired boiler unit, but not giving the coal preparation system, is shown in Fig. 4, and the principal particulars of each unit are as follows :—

Boiler heating surface	16,510 sq. ft.
Murray wall heating surface	1320 sq. ft.
Water screen heating surface	470 sq. ft.
Superheater heating surface	4300 sq. ft.
Economiser heating surface	6000 sq. ft.
Air heater heating surface	19,920 sq. ft.
Combustion chamber volume	11,450 cu. ft.
Number of burners	10

The boiler sections of each unit are of Babcock and Wilcox C.T.M. design with vertical headers. Each boiler is carried on a separate steel structure, the front headers being suspended and the main drum supported on brackets. The superheater is arranged in the space above the fourth row of lower tubes, and is supplied with saturated steam from two steam outlets on the main drum. The steam leaves the main drum through two Tracey steam purifiers. The boiler is baffled to provide three gas passes and a soot and fly ash hopper forms part of the structure below the second and third passes. This hopper is connected by pipes provided with valves to an hydraulic ash sluice in the basement. Each boiler is provided with three Cockburn double spring-loaded safety valves ; one on the main drum and one on each superheater outlet. The main steam drum safety valves are each fitted with a pilot whistle which gives audible warning when the pressure exceeds the normal working pressure by 5 lb.

The superheater is constructed in two sections one for each steam outlet connection. These superheaters are of the Superheater Company's M.L.S. type with the headers external to the boiler gas passes. Three sides of the combustion chamber carry steam generating heating surfaces in the form of Murray fin tubes. The tubes are grouped vertically and are expanded at either end into headers external to the combustion chamber casing. These headers are connected by circulating pipes to the boiler drum. The water screen at the bottom of the combustion chamber consists of plain tubes arranged at a slight inclination to facilitate circulation. Each tube is expanded into external headers, which also connect with the rear Murray wall tubes, and by circulating pipes with the boiler drum. Below the water screen the combustion chamber is of V shape construction, and forms a receptacle for falling ash. The front combustion chamber wall is built of fire-brick, and carries the air ports through which the secondary air is admitted to the furnace. The space between the wall and the front of the combustion chamber casing is divided into horizontal sections and connects at each end with the forced draught ducts, which come down the sides of the boiler casing from the air heaters. A hinged damper, controlled by a common spindle from the operating floor, is fitted at each horizontal section inlet. One such damper assembly is fitted at each side. The single dampers can be individually adjusted on the main spindle, and after once being correctly set are operated as one. Other dampers, but with coarser regulation, are fitted in the main air ducts slightly above the operating floor level. The economisers are fitted above the boilers and are of the Foster gilled-tube type and have a single gas pass. The air heaters, of the Underfeed Stoker Company plate type, take the economiser flue gas discharge. The air supply is taken from immediately below the boiler-house roof by a double inlet forced draught fan, which discharges through the single-pass air heater to the two main air ducts. The flue gases make a single pass through the air heater and, from there, are taken by two ducts to the two induced draught fans, which discharge the gases through grit extractors and thence to the chimney. The air heaters are designed to reduce the final gas temperature to a value not exceeding 250 deg. Fah.

The mechanical draught equipment of each unit comprises one forced draught and two induced draught fans of Davidson's "Sirocco" type, each driven by a variable-speed, enclosed, ventilated-type, 415-volt alternating-current motor. Each motor is operated by push button controls on the instrument board on the operating floor. The stators of the induced draught fan motors have two separate windings, each winding corresponding to two fixed speeds. Intermediate speeds are obtained by rotor resistance control, the rotor being of the wound type and provided by six slip rings, three for each winding. The forced draught fan motors are of similar design to those driving the induced draught fans, except that the stator has one winding only and speed regulation is entirely effected by rotor resistance control. In addition to the draught equipment mentioned, each unit is fitted with a motor driven fan supplying primary air to the burner feeders. This fan takes its supply from one of the main air ducts on the discharge side of the air heater, and supplies preheated air to a common header with branch connections to each of the burner feeder groups on each boiler. The fan runs at a fixed speed, the air quantity being controlled by means of dampers, but starting and stopping is accomplished by push button controls on the boiler unit instrument panel. Emergency local controls are also provided.

Each boiler unit has five burner feeders carried on the bottom of the pulverised fuel bin and each feeder supplies two Lopulco fan-tail type burners, to which they are connected by pipes. The burner feeder assembly of each unit is driven by a 6 H.P., 110-volt, direct-current, variable-speed motor, controlled normally from the boiler unit instrument panel, but provided with local control for emergency use. The five feeders are driven from a common shaft coupled to this motor, and friction clutches are provided so that any of the five pairs of burners can be controlled separately.

The equipment provided for soot-blowing purposes consists of Parry and Diamond valve-in-head soot blowers. At the top of the combustion chamber there are three Parry blowers, arranged to blow upwards into the first gas pass. The remaining gas passes of the boiler are fitted with six Diamond blowers, controlled from each side of the unit. The economiser has two Parry blowers arranged in the gas pass between the boiler outlet and the economiser inlet. Soot pipes have been provided for the removal of soot from each unit. This system includes soot hoppers at the base of each chimney, discharging into the grit boxes of the dust collectors. All these are coupled by a piping system, fitted with the necessary valves, to the ash sluicing trough in the basement.

Each boiler unit is arranged for automatic feed-water regulation. Five of the units are equipped with regulators of the Cope type, four with Crosby type, and one with a Hopkinson Duo regulator. Dust extraction from the discharged flue gases is provided for by the installation of two Davidson's shunt pressure type grit extractors on each unit, erected on the roof between the induced draught fans and the chimney. Each induced draught fan discharges the flue gases into the main cyclone of each assembly, from which a small portion of flue gas containing most of the dust is collected and passed to a secondary cyclone for final precipitation. The precipitated dust and grit are discharged to the grit boxes and from there they are periodically cleared to the ash sluice.

One self-supporting steel chimney is provided for each pair of boilers, and each chimney is carried on a steel structure raised above roof level, the space beneath the chimney forming an aisle between the two rows of mechanical draught and grit extraction equipment.

The coal preparation plant consists of ten complete Lopulco systems, one unit of this system—complete with bin and feeders—being provided for each boiler unit. This plant is accommodated between the basement and roof level along each wing aisle of the boiler-house. The raw coal is delivered from the filler pits by gravity bucket conveyors, as previously described, to two lines of bunkers, there being five bunkers in each line and each bunker serves one coal preparation plant and boiler unit. The steel bunkers are brick-lined and each bunker is provided with three outlets connected to chutes carrying the raw coal to the feeder gear of the mills. The chutes have been fitted with removable sections at the operating floor level, so that a Simons automatic coal weigher can be incorporated for test purposes. Each line of five bunkers

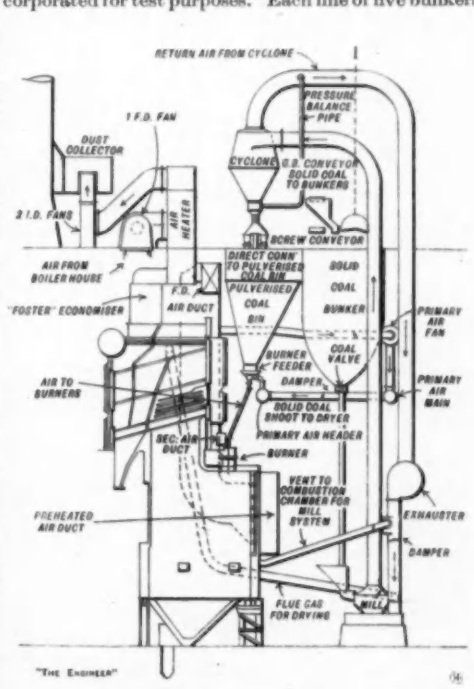


FIG. 5—PULVERISED FUEL EQUIPMENT

has a self-trimming capacity of approximately 1300 tons. The coal discharged to these bunkers is passed over a magnetic separator, forming part of the conveying system in each of the two filler pits serving No. 2 boiler-house, for the purpose of removing tramp iron, &c. The milling section of the plant comprises ten units, each of which consists of a combination of pulverising mill, exhauster fan and cyclone separator. Fig. 5 shows diagrammatically the lay-out of the preparation plant.

Each Raymond mill is driven by a 200 horse-power, variable-speed, alternating-current motor, and is connected to its respective raw coal bunker by means of chutes which discharge to the mill through a hopper and motor-driven feeder gear, by means of which the input to the mill is regulated. The mill forms part of a closed coal and air duct system, the powdered fuel being drawn from the pulveriser directly to the cyclone separator, which is above road level. Here the fuel is separated from the carrying air, and falls to the bottom of the cyclone. The air is drawn from the top of the cyclone and returned to the mill by a motor-driven exhauster fan in this leg of the circuit. This arrangement of the exhauster ensures that only a small proportion of powdered coal is

handled by the fan runner, thus reducing the wear on this component to a minimum, and the only section of the system which is above atmospheric pressure is a small portion between the exhauster and the mill, with the result that leakage of coal dust from the units or ducts of the system is guarded against. Each exhauster is driven by an 80 horse-power, alternating-current motor. Drying is effected in the mill and air system of each plant by bleeding a percentage of flue gas from the boiler unit, and introducing it directly to the mill, a damper on the ducting controlling the quantity of gas. Cooled gas and air are vented from the system at a point between the bled gas inlet and the exhauster, and the vent is coupled by a damper controlled duct to the combustion chamber, into which it discharges at a point just above the water screen. The capacity of each coal preparation plant is 15 tons per hour. From the bottom of each cyclone the pulverised coal is taken through a rotary air lock to three chutes, each of which is fitted with a valve.

The two outside chutes discharge to screw conveyors, while the centre chute discharges direct to the pulverised coal bin situated above the burner feeders of each boiler unit. The lay-out of the pulverised fuel bins is symmetrical with the boiler units and raw coal bunkers, and flexibility in operating the plant is greatly assisted by a system of motor-driven screw conveyors carried on the pulverised fuel bin tops with controlled discharges into the bins. These screw conveyors, which each have a capacity of 16½ tons per hour, connect each coal preparation plant and it is therefore possible to maintain a supply of pulverised fuel to the bin of a sound boiler unit, whilst the preparation plant of that unit is out of service.

The Greenwich Fuel Research Station.

The pulverised fuel plant installed at the Greenwich Fuel Research Station, which was visited by the Institute, may be divided into two main sections, the first containing apparatus of a purely experimental nature, while the second consists of more or less standard equipment.

The first section is devoted mainly to the study of scientific principles involved in the combustion of powdered fuel in small spaces and also to testing short-flame burners, qualitatively, without actually fitting

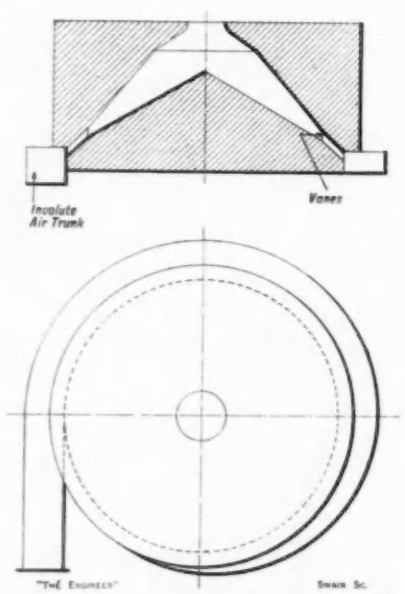


FIG. 6—VORTEX COMBUSTION CHAMBER

them into a boiler. The apparatus is constantly changing and the experimental work ranges from the measurement of velocity distribution in cardboard models to combustion tests upon burners dealing with about 400 lb. of coal per hour. The second section, which has recently been completed, is intended to enable complete boiler trials to be carried out on a sufficiently large scale for the results to indicate what may be expected in commercial practice. It is proposed to carry out extensive trials following a series of programmes dealing with such matters as the testing of different types of burners, both commercial and experimental, and the effect upon combustion and boiler efficiency of variations in individual physical and chemical properties of the fuel used.

Three examples were given of the method of development of apparatus involving variations in the application of fundamental principles, one in its early stages, one ready for test in the standard plant, and one at an intermediate stage. It is well known that the main difficulty in burning pulverised coal lies in obtaining contact between the minute coal particles and the oxygen required for their combustion. In some cases this is secured to a greater or less extent by turbulent motion and mixing, but the vortex chamber deliberately departs from most burners or combustion chambers by making use of streamline motion and by attempting to control the relative movement of the fuel and air, the effect aimed at being equivalent to having a stationary bed of fuel through which air passes. The method employed is to cause the air for combustion to take up a spiral vortex motion from the circumference to the centre of a cylindrical combustion chamber into which the fuel is introduced in pulverised form. Owing to the action of the air each solid particle will rapidly acquire a rotational velocity, approaching that of the air about the axis of the cylinder, and will therefore tend to travel outwards under the action of centrifugal force. But since the air is travelling from the circumference to the centre of the chamber, it will also have an inward radial velocity component and will therefore tend to carry the solid particles inwards.

If by suitably proportioning the combustion chamber the inward and outward forces on the particle

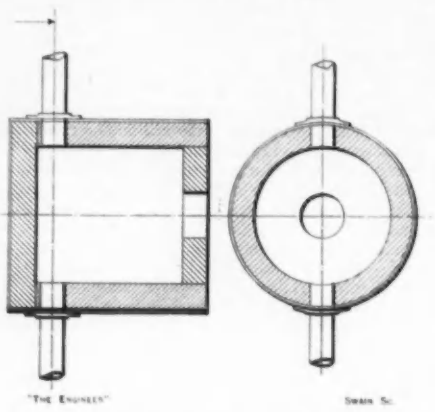


FIG. 7—IMPINGING JET COMBUSTION CHAMBER

can be equalised, the particle will tend to rotate at a constant radius, which may be called the equilibrium radius, depending on the size and density of the particle and the velocity and temperature of the air. With a number of particles, and considering only radial movement, the effect is secured of a stationary cylindrical bed of fuel through which air travels radially from the outside to the central axis. The principle was illustrated by two models, in one of which water was used as the fluid and was discharged with a spiral vortex motion through an orifice at the base of a cylindrical vessel. Red lead is used as the solid and outlines a rotating cylinder, the diameter of which can be controlled by varying the rate of discharge of the water. In the other model air is used as the fluid and finely divided ash particles as the solid. The first experimental combustion chamber designed on this principle was shown in operation burning about 400 lb. of coal per hour in a chamber having a volume of 2¾ cubic feet—see Fig. 6.

At the time of its construction the main object of this particular furnace was to discover whether the conditions predicted from a mathematical examination of the probable motion of a fuel particle could be set up under practical conditions, *i.e.*, to test the practicability of the fundamental idea rather than to attempt a final design.

It was therefore decided to construct the combustion chamber as simply as possible, using ordinary fire-brick without water cooling and to introduce the fuel with the air through a circumferential involute instead of from a separate source, whilst the possible fusion of the fire-brick as a result of the high heat release was avoided by limiting the air supply so that only the producer gas reaction took place, the temperature of this reaction being below the fusion point of the bricks used. With this chamber the results obtained appeared to be in good agreement with those predicted from theoretical considerations, it being possible to run at full capacity, using good producer gas, with very little smoke indeed. Visual examination indicated that the fuel took up an equilibrium radius, which was confirmed by examination of the brickwork on cooling. In spite of the high heat release, the brickwork remained in good condition after many hours' running, and the metal vanes through which the air was supplied showed no signs of overheating. Nor was any trouble experienced owing to the accumulation of ash or clinker in the chamber. The principal difficulty was a tendency for part of the combustion chamber near the intake vanes to choke with a light feathery coke. This was apparently due to bad distribution and partly to the presence of oversized particles, and steps have been taken to overcome the trouble.

The second combustion chamber to be demonstrated originated from a suggestion by Dr. Stanton, of the National Physical Laboratory, that a simple form of vortex chamber might be constructed by causing two equally opposed streams of air to impinge directly upon one another on the axis of a cylindrical chamber closed at one end and open at the other. When the scheme was tried on a full scale, however, it was found that, although vortex motion was set up, it was far too weak for its purpose, and an attempt was then made to intensify the action by closing the open end of the chamber except for a comparatively small central orifice. The chamber was then brick lined and pulverised fuel introduced with two air streams, the proportions of air and fuel being again regulated so as to permit of only the producer gas reaction taking place.

On ignition it was found that the flame leaving the combustion chamber had no swirling motion, such as that observable with that from the vortex chamber, but the flame was, nevertheless, quite short and very compact. So far this equipment has only been tried in the open, but judging by appearances, it should ultimately approach the ideal when used with a Lancashire or marine boiler. The only difficulty experienced in operation has been a tendency for a light feathery coke to accumulate in the chamber, but it appears to last only for the first half hour or so after lighting up. The combustion chamber has been in operation for six hours at a time without collecting any more coke than was present at the end of the first half hour. The combustion chamber shown in Fig. 7 is a first design, and its dimensions were chosen quite arbitrarily, and it is considered quite possible that the difficulty mentioned may be overcome merely by altering the dimensions or by providing doors in the closed end of the chamber; but in any case the method is considered promising and worthy of further investigation, if only on account of its extreme simplicity.

The third experimental plant shown in operation is known as the grid burner—see Fig. 8—and has reached the stage at which it is ready for trial in an actual boiler. In Germany considerable success appears to have been achieved in firing locomotive and other small high-duty combustion chambers by means of pulverised fuel burners, in which the essential idea is the division of the main air and fuel supply into a number of small jets, similar in some cases to those of the well-known Meker gas burner. In the "grid burner" the same method has been carried a stage further by supplying the primary air and fuel through a number of narrow slots, so as to form a number of thin parallel sheets of fuel and air, and then introducing between them similar thin sheets of pre-heated air. As far as can be seen from tests in the open, a burner with an area of 9in. by 9in. will satis-

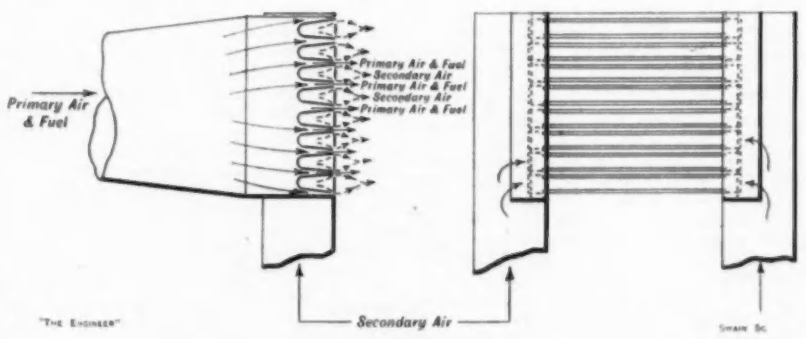


FIG. 8—GRID BURNER

factorily burn over 600 lb. of pulverised coal per hour, of which 60 per cent. passes through a 200 mesh, the flame then being about 7ft. long. Although exposed directly to the radiant heat of the flame, the front of the burner does not overheat, and after considerable testing, the grid containing the slots through which the fuel and air pass shows no signs of deterioration. The three burners mentioned are shown in Fig. 9, where the grid burner is to be seen on the left, the vortex burner in the centre, and the impinging jet burner on the right.

Following the normal practice of the Fuel Research Station of conducting tests upon the smallest unit large enough to be considered representative of commercial practice, two boilers have been equipped for carrying out comprehensive trials of pulverised coal. The first, which is to be seen in the background of Fig. 10, is a small Babcock and Wilcox land type water-tube boiler, having a heating surface of 1619 square feet and fitted with an integral superheater with a heating surface of 284 square feet. For firing with

FUEL RESEARCH STATION AT GREENWICH

FIG. 9—PULVERISED FUEL BURNERS

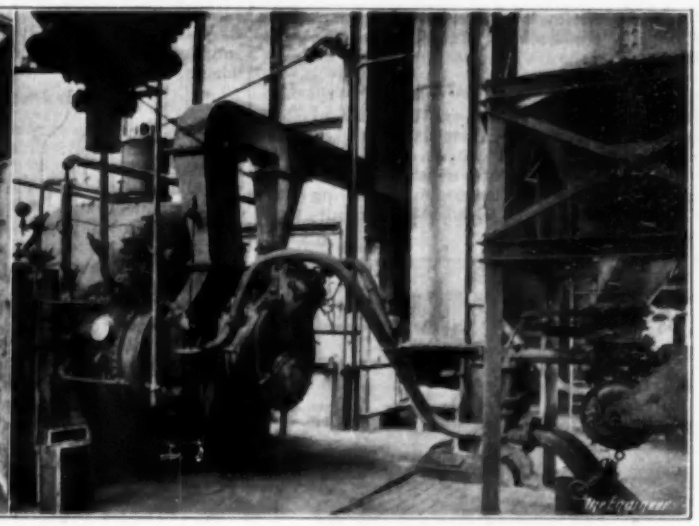


FIG. 10—EXPERIMENTAL BOILER PLANT

pulverised fuel, this boiler has been raised 9ft. 4in. above its original position in order to increase the size of the combustion chamber to 1015 cubic feet capacity. The boiler is rated at 5750 lb. per hour, and is guaranteed by the makers who have carried out the alterations to give an efficiency of 74 per cent. when using their Lodi type burner.

The second boiler—see Fig. 10—is a standard dish-ended Thompson Lancashire boiler, 28ft. by 7ft. 6in., working at a pressure of 150 lb. per square inch. Beyond the removal of the normal grate and furnace front, and the insertion of a fire-brick lining for the first 3ft. of the flues, no radical alteration has been made in this boiler for pulverised fuel firing. In arranging the demonstration for the members of the Institute of Fuel, it was felt that in view of the developments taking place in connection with firing Lancashire and Scotch marine boilers with pulverised fuel, an exhibition of different types of burners for this purpose would be of interest. At the time of the visit each flue of the Lancashire boiler was therefore fired for demonstration purposes by one of the various commercial burners upon which it is proposed to carry out complete tests and other turbulent or short-flame burners were laid out for inspection with explanatory diagrams.

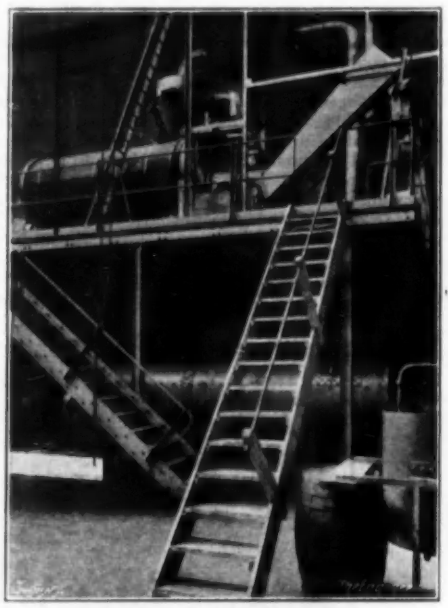


FIG. 11—DRYER AND MILL

The coal used to fire the experimental boilers is first elevated to an overhead bunker, from which it is delivered to a Pehrson dryer—shown in the upper part of Fig. 11—having a capacity of 1 ton per hour. This dryer is in the form of a cylinder, 9ft. 10in. long by 3ft. 11in. diameter, rotating at 1·5 r.p.m. Coal is fed into the centre of the cylinder at one end and by the rotary movement is constantly turned over as it passes along to the other end, where it is discharged through a central orifice, the size of which can be adjusted to vary the depth of the fuel bed. Heating is carried out by means of hot combustion products which are supplied through an annular space between the outer casing of the dryer and the inner cylinder built up of a set of louvres in such a way that the heating gas passes only through those louvres upon which coal is resting, and thus finds its way through the coal into the centre of the inner cylinder. The cool gas is withdrawn at the feed end and passes to a cyclone for dust removal. The total power taken by the dryer is about 5½ H.P., and about 2000 B.Th.U. are used per pound of moisture evaporated.

After leaving the dryer, the coal passes over a feed table to an Edgar Allen tube mill, 20ft. long by 3ft. 4in. diameter, rotating at a speed of 37 r.p.m., and having a capacity of 1 ton per hour. The mill, also to be seen in Fig. 11, contains about 6½ tons of balls in three graded sizes, and is driven by an 80 H.P. motor. This type of mill was chosen mainly in order to be able to ensure carrying out long series of tests with the minimum variation in the fineness of the fuel delivered by it.

From the mill the powdered fuel passes to one or both of two bins, each of 2½ tons capacity and fitted with twelve Waring filters. At the base of each bin are variable-speed screw feeders delivering into a primary air supply coming from an underground duct fed by a Davidson fan taking about 4 H.P. A similar fan delivers into an overhead bunker, from which secondary air may be taken. The whole plant is so arranged that almost any normal short flame burner can be fitted up for trial with the minimum of alteration.

It will be realised that in carrying out the experiments referred to in the above description of the equipment at the Fuel Research Station necessitates a considerable amount of laboratory work. Unfortunately, time did not permit the members of the Institute to inspect the laboratories at the Station, but a considerable amount of apparatus is used in the laboratory for the examination of the coals used. Here also studies are made of such properties of the fuels as are likely to offer some clue as to the mechanism of pulverised fuel combustion. One such investigation, for example, deals with the formation and properties of cenospheres, the hollow latticed spheres often found in the neighbourhood of boiler furnaces, particularly those burning pulverised fuel. It is suspected that the property of forming cenospheres has an important bearing upon the combustion of certain fuels, and, indeed, that in some cases powdered fuel could not be burned in the time available for its combustion if cenospheres were not formed.

ROAD TRANSPORT.

In the presidential address to the Institution of Locomotive Engineers on Thursday, September 25th, Mr. H. Kelway-Bamber said :—

As in 1830 the coming of railways affected the interests of road-borne traffic, so to-day the pendulum swings in the opposite direction, and railway authorities inveigh against the inroads of motor-driven vehicles throughout the world. In course of time, and given reasonably comparative conditions enforced by law, the one will prove to be a helpful complement to the other.

The influence of the motor vehicle on the life of nations is likely to be as revolutionary as was that of the coming of the steam engine. It can and does penetrate in a manner impossible to railways, and opens up prospects of improved methods of travel which the public will rightly insist upon.

What is most desirable is an intelligent and thorough-going examination of the conditions as they apply in ever-changing degrees from cottage, farm, and factory door, *viâ* motor vehicle, to the railway station or other destination. In all forms of vehicular transport the services of the engineer will be in demand, but he must be an engineer possessed of broad views and practical training, ever watching the movements of events and responding to them. These conditions can only be attained by persevering effort, technical training, and comprehensive study.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE SAMPLING OF COAL.

SIR,—I have read your to-day's leader with interest. It is possible to over-estimate the value of laboratory tests in small coal samples.

For suitability and economy the results aimed at should be by actual practice under working conditions. Domestic coals should be tested for quickness of kindling and specific gravity of the ash. Shipping coals for hardness; industrial coals for sulphur, and freedom from clinkering and the fusion point of the ash. Small receiving devices could be fixed, so that a small sample of the coal flow could be taken at intervals when loading for transportation, then bulked and a sample taken to a test-house, suitably equipped to report on the lines stated above.

GEORGE H. WILLOCK,
Slough, September 26th. M. Inst. Pet. Tech. Fuel.

NATIONAL CERTIFICATES IN MECHANICAL ENGINEERING.

AN arrangement has existed for the past six years whereby, when a candidate for a Higher National Certificate in Mechanical Engineering at the termination of an advanced course includes a specialised automobile engineering subject in his final examination, the signature of the president of the Institution of Automobile Engineers can be added to any certificate which may be awarded.

The arrangement has now been extended to ordinary certificates awarded at the termination of senior part-time courses, and it has also been agreed to consider applications for approval of supplementary senior part-time courses with a view to the endorsement of automobile engineering subjects on ordinary certificates previously awarded at the termination of courses of a more general type. Such applications should be addressed in the first instance to the Board of Education, and requests for the addition of the signature of the president of the Institution of Automobile Engineers to certificates awarded, or subsequently extended under these conditions, should be made to the Institution of Mechanical Engineers at the time when the results of final examination are submitted. The arrangement relating to supplementary courses applies also to the Higher Certificate.

The Council of the Institution of Mechanical Engineers hopes that this announcement will receive the attention of members who are interested in the training of apprentices in automobile engineering, or in the work of technical colleges in districts where automobile engineering is one of the local industries.

The scheme for the award of National Certificates in Mechanical Engineering has been recently further widened in order to make better provision for the foundry apprentice who aspires to supervisory rank in the foundry or to the position of what might be termed a "foundry engineer," first, by admitting a proportion of subjects associated with the work of the foundry into the curriculum of senior part-time courses leading up to the award of Ordinary National Certificates; secondly, by allowing further specialisation of the same character in the advanced part-time courses for the Higher Certificate, and thirdly, by considering applications for approval of supplementary senior and advanced part-time courses with a view to endorsing subjects associated with the work of the foundry on certificates previously awarded at the termination of courses of more general types. It has been agreed with the General Council of the Institute of British Foundrymen that certificates originally awarded, or subsequently extended on the termination of approved courses, of this type, should have added to them the signature of the president of the Institute of British Foundrymen, and the Council of the Institution of Mechanical Engineers desires to commend that arrangement also to the attention of all concerned.

The Building Exhibition.

No. II.* (*Conclusion*).

We conclude below our description of some of the machinery at the Building Exhibition at Olympia, which closed on the 1st inst.

Ransomes and Rapier, Ltd.

The principal item shown on the stand of Ransomes and Rapier, Ltd., of Ipswich, was the concrete mixer illustrated in Fig. 7, which is capable of dealing with from 80 to 90 cubic yards of material per shift of eight hours. It is, as will be seen, of the tilting drum type, and is driven by a 6½ horse-power four-stroke

Fig. 7—Concrete Mixer—Ransomes and Rapier

Lister engine through chain gearing. A noteworthy feature is the high angle to which the loading scoop can be raised, so as to ensure a ready discharge of its contents. The wheel arrangement also is peculiar, in that all four wheels are mounted on stub axles to enable the machine to be moved either longitudinally, while the front wheels have an Ackermann steering system for travelling on the road.

Aveling and Porter, Ltd.

Although one naturally associates the name of Aveling and Porter, Ltd., Rochester, with road rollers and with traction engines, the exhibits of this firm were essentially connected with the building trades. They comprised some concrete mixers and a hoist for builders' barrows. This hoist is driven by a 4 horse-power engine and has a maximum capacity of 7 cwt. It is suitable for service in connection with a 5 cubic feet concrete mixer.

Of the concrete mixers there were two, one of 5½/3½ and one of 10/7 cubic feet capacity. That is to say, they will take those amounts, respectively, of dry aggregate and wet concrete. We illustrate one of these concrete mixers in Fig. 8, which shows that

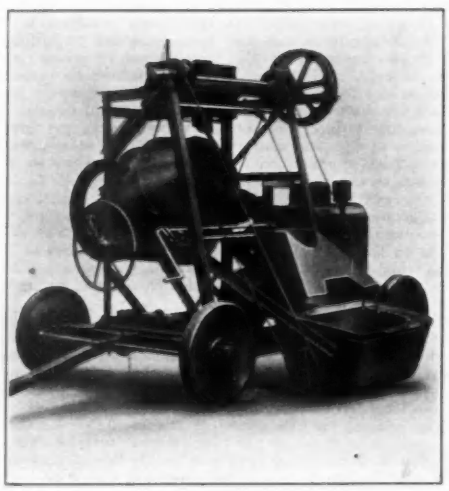


Fig. 8—Concrete Mixer—Aveling and Porter

it is of the tilting drum type, with a swinging loading hopper. It is claimed to be capable of producing forty batches, or 10 cubic yards per hour, and is driven by a 4½ horse-power petrol engine. Its general construction is fairly normal, but the water dispensing arrangements are novel. In an overhead tank the water level is kept constant by a ball cock. Within this tank there is a sector-shaped dipper, which can be tilted to discharge its contents down a shoot into the concrete mixer. This dipper is mounted on vertical slides and can be immersed more or less in the water in the tank, according to the amount of water which it is desired to add to the concrete. There is a dial graduated to indicate the amount of water delivered. The other concrete mixer which was shown on this stand has a capacity of from 25 to 30 yards per shift of eight hours and is driven by a 1½ horse-power engine. Its framework is built up of steel sections electrically welded together, and it is supplied either with two wheels and a leg or with four wheels.

* No. I. appeared September 26th.

Butters Brothers and Co.

There were some very neat models of cranes on the stand of Butters Brothers and Co., McLellan-street, Glasgow. They included derrick and other types of cranes and a very fine model of a mono-tower crane of the type which was such a familiar landmark in London during the rebuilding of Baker-street Station. One of these cranes, of 5 tons capacity, has recently been supplied for the building of Liverpool Cathedral, and will be at work on the job for seven years. It has a tower 185ft. high and a jib 110ft. long, so that it has a total lifting height of 300ft. and a radius of 100ft. The mast which supports the jib and counterweight is some 125ft. high, but approximately half that height lies below the top of the tower. In the course of erection the mast is built up, vertically, within the tower at the bottom, and is then hoisted up into place bodily. It is claimed that the Liverpool crane is the highest in the world.

Wadkin and Co.

On the stand of Wadkin and Co., Leicester, a wide range of modern woodworking machinery was exhibited. Each of the machines shown was self-contained, electrically-driven, and many of them were seen running.

A machine to which particular attention was given was an electric-drive tenoning machine, which tenons, scribes the shoulders, and cuts off dead to length with one pass through the machine. It will make tenons with unequal shoulders, angle tenons and double tenons. It will take timber up to 24in. wide, 6in. deep, and tenons 6in. long can be cut at one operation. In addition to tenoning operations, cross-cutting, trenching, housing, &c., can be done.

Five separate motors are built into the machine, with the cutter blocks and cut-off saw mounted directly on to the ends of the motor shafts. Each motor is totally-enclosed and fully protected from flying chips and sawdust. Independent adjustment is provided for each cutter head. The main top and bottom heads may be connected and adjusted together to facilitate the locating of centring of tenons. Each motor is started up independently by simply pressing a push button, which is mounted on a panel in the most convenient position on the machine. A master stop button mounted in an equally convenient position stops all motors simultaneously. All the electrical contactor gear, with the exception of the push-button

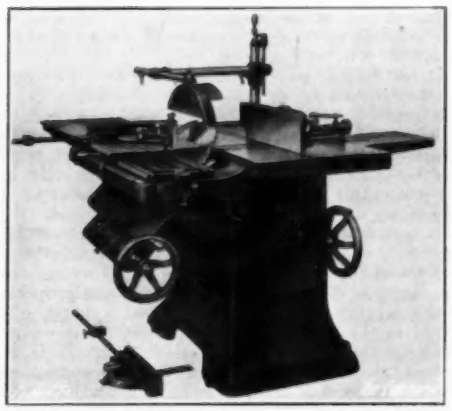


Fig. 9—Canting-Spindle Dimension Saw—Wadkin

stations, is neatly mounted on the side of the machine and fully enclosed.

The table has a particularly free movement, as it is arranged to run on ball-bearing rollers. The fence on the table may be set in various positions which allows of angular cutting. Independent quick-action lever clamps hold the timber in position.

Another machine was a cross-cutting and trenching machine, which can be used either for cross-cutting, trenching or grooving. As a cutting-off saw, it will do practically all the cross-cutting dead to length for constructional building, and with the saw removed and a grooving head fitted, it is ready for half lapping, grooving, trenching, birds-mouthing, &c.

The machine is built on the straight line principle, that is, the saw moves forward in a dead straight line, and not in an arc as with a pendulum saw. In addition to this movement, the saw carriage has a rise-and-fall movement, a swivelling movement up to 45 deg., and a canting movement. With such a wide range of movements a very wide variety of cuts can be made. The saw spindle revolves on ball bearings and carries a 5 H.P. motor. Very little exertion is required to work the machine, as the saw carriage slide is mounted on ball bearings. Locking devices are provided on all movements for giving a positive lock in any position.

The motor is operated by push-button start and stop, the contactor gear being mounted integrally with the machine. With a standard saw of 18in. diameter, the machine will cut off between the limits of 20in. wide, 4½in. deep, and 25in. wide, 1in. deep. With a grooving head fitted in the place of the saw, it will groove up to 2½in. wide, 1½in. deep, in material 18in. wide. When the carriage is pivoted up to 45 deg. the same size of grooves can be made in material 12in. wide. The table may be either of wood built up on four cast iron standards or, alternatively, an all-metal table embodying anti-friction rollers which ensures maximum output being obtained when on production work, can be supplied. The table top is fitted with a graduated stop bar carrying a number of automatic stops, which dispenses entirely with the necessity of marking out.

Among other machines on the stand was a 20in. combined planing and thicknessing machine, with separate motors for both cutter block and feed motion. The direct coupling of the motor to the cutter block eliminates all side pull on the bearings, and the absence of whip or strain on the cutter block and the steadiness of the feed motion ensure accurate and smooth work. The safety circular cutter block runs in heavy ball bearings. The raising and lowering motion to the bottom table is effected by screws protected from dust. Three rates of feed are provided, which can be changed instantly by hand lever whilst the machine is running. The front table can be arranged to tilt for taper planing.

Perhaps one of the most interesting machines on the stand was a canting spindle dimension saw—see Fig. 9. This machine will rip, cross cut, and mitre in any kind of wood, and the cut is made so smoothly that a joint can be glued up straight off the machine. The outstanding feature of this machine is that the saw is arranged to cant, and not the table, as is usually the case. Practical woodworking men will readily appreciate the advantages of working angular cuts with the table always in a horizontal position. Not only, it is claimed, does it ensure an increase in production of anything up to 30 per cent., but the operator is afforded a greater degree of safety by reason of the more natural working position. The motor is self-contained in the machine and mounted directly on the saw spindle. The table is divided into two parts, the front portion which carries the wood sliding past the saw on ball bearings. A movement of the table away from the saw allows of grooving saws and cutter heads being used. The machine is started up and stopped by push-button controls mounted in the most convenient position for the operator.

Two different chain and chisel mortising machines were shown. Both models will take timber up to 12in. deep by 8in. wide. The maximum size of mortise, using chain, in both cases, is 1¼in. by 3in. by 6in. deep, and with the square hollow chisel the maximum is ¾in. One of these machines has both the chain and the chisel headstocks mounted side by side on the machine, each operated by handles mounted on the right-hand side of the machine. Either the chain or the chisel can be used as desired, by simply pulling down the required lever. The machine has the motor built into the base, with a belt driving up from the inside of the main frame on to the chain and chisel headstocks. The drive to both the chain and the chisel spindles is taken through clutches, which are automatically thrown out of engagement when the chain or hollow chisel is withdrawn from the timber.

Fig. 10—Boring and Recessing Machine—Wadkin

The second mortising machine exhibited is arranged for taking one headstock only, but is so arranged as to be readily converted from chain to chisel. On both machines a self-contained ratchet feed-cutter grinder is included.

There were also an electrically-driven vertical spindle moulder, an electrically driven band saw, two small planers, and the boring and recessing machine illustrated in Fig. 10. This machine, which was exhibited for the first time, will bore holes up to

3in. diameter by 12in. deep. The boring spindle runs at speeds of from 1250 to 2600 r.p.m. The machine is capable of a very wide range of operations, such as recessing, shaping, grooving, slot mortising, cutting housings in string boards, &c. A special feature of its design is that the spindle is mounted in a sliding sleeve which allows of the bearing being kept close up to the spindle chuck in every position. With the spindle supported in this manner it will be obvious that vibration is reduced to a minimum, and that better and more accurate work is assured.

Three other machines exhibited for the first time were a circular saw sharpener, capable of taking saws from 8in. to 72in. in diameter and sharpening teeth at the rate of either thirty or sixty per minute; an automatic band saw filer and setter; and an electric band saw brazer.

J. Sagar and Co., Ltd.

On the stand of J. Sagar and Co., Ltd., of Canal Works, Halifax, England, there was a large collection of woodworking machinery, including several planing, thicknessing machines, a ripping saw, a band saw, a vertical spindle moulding machine, a double-spindle recessing machine for stair strings, a tenoning machine and two mortising machines. We illustrate one of the latter in Fig. 11.

As will be seen from the engraving, this machine has two cutter heads, one fitted with a chain cutter and the other having a hollow square chisel with an internal rotary bit. They are both driven independently by electric motors. The motor for the chain cutter is arranged within the standard of the machine and is mounted on a vertical slide, so that it can be directly connected with the top sprocket of the chain cutter. The motor is of 4 horse-power.

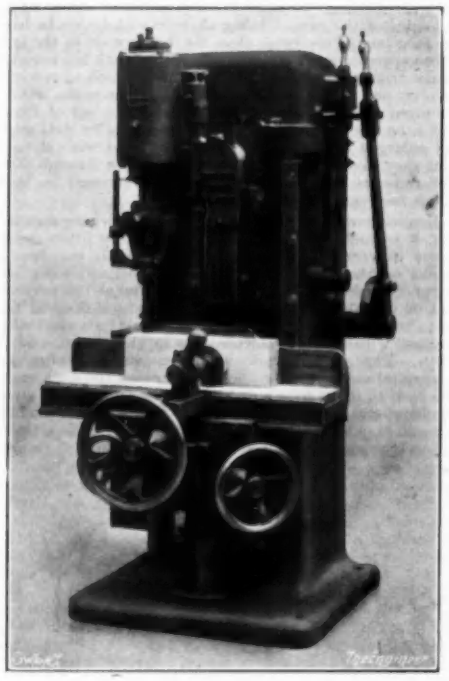


Fig. 11—Mortising Machine—Sagar

The motor for the rotary bit of the chisel is of the vertical spindle type, and is plainly shown in the illustration at the top of the machine. It is of 1 horse-power and runs at 3000 revolutions per minute when supplied with 50-cycle current. On the right of the machine there will be seen the hand feed levers for the two tools. These levers are interconnected with the starters of the motors, so that the tools are set in motion immediately the feed is started and stop again at the end of the cut. The worktable, it will be seen, has a rise and fall movement and slides in both directions. The machine will take timber up to 11in. deep by 6in. wide, and is suitable for mortising with the chain cutter any size between $\frac{5}{16}$in. to 1in. wide and from $\frac{3}{4}$in. to $2\frac{1}{2}$in. long at one cut, but longer mortises can be made by two or more strokes. The hollow chisel attachment is suitable for making mortises from $\frac{1}{4}$in. to $\frac{3}{4}$in. square.

Marshall, Sons and Co., Ltd.

There were three concrete mixers on the stand of Marshall, Sons and Co., Ltd., of Gainsborough, one of which we illustrate in Fig. 12.

The drum of this machine is 4ft. 9in. in diameter by 3ft. 4in. wide and has ends of steel plate pressings, to which the wrapper plate is riveted. It is fitted with two mild steel tires, machined on the face and edges, and with a cast iron gear ring made in four sections. This ring is bolted in place so that it can be readily renewed should any of the teeth be accidentally broken. It is driven through a forged steel pinion by a 10 horse-power Lister single-cylinder engine. The weight of the drum is taken by cast iron anti-friction rollers with chilled faces. The loader skip is hoisted by a wire rope gear, which is engaged by a clutch and is held by a brake in the raised position. The raising gear is automatically knocked out when the skip is in the discharging position. For discharging the drum a semi-circular shoot is passed into the drum to catch the contents as they cascade over the mixing blades. The water measuring tank for supplying the water

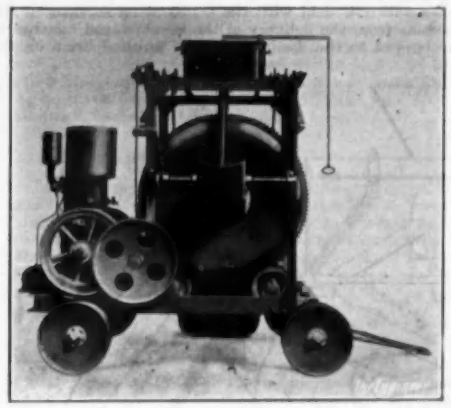


Fig. 12—Concrete Mixer—Marshall

necessary for the mix is fitted with a ball float valve which can be set to provide any predetermined amount of water, and there is also a glass water gauge.

Stothert and Pitt, Ltd.

Stothert and Pitt, Ltd., of Bath, had several concrete mixers of familiar types, and the builder's hoist which we illustrate by the drawing, Fig. 13. This hoist is of $\frac{1}{4}$ cubic yard capacity and works in conjunction with a mixer of the tilting barrel type, having a mixed batch capacity of 5 cubic feet. This mixer is ordinarily driven by a 4 horse-power Lister engine, but when the hoist is added a $6\frac{1}{2}$ H.P. engine is substituted. There is an extension on the gear shaft, which carries a drum for the hoisting rope.

The hoist itself is built up of light channels and bracing bolted together, so that it can be heightened as the building progresses. When it is desired to

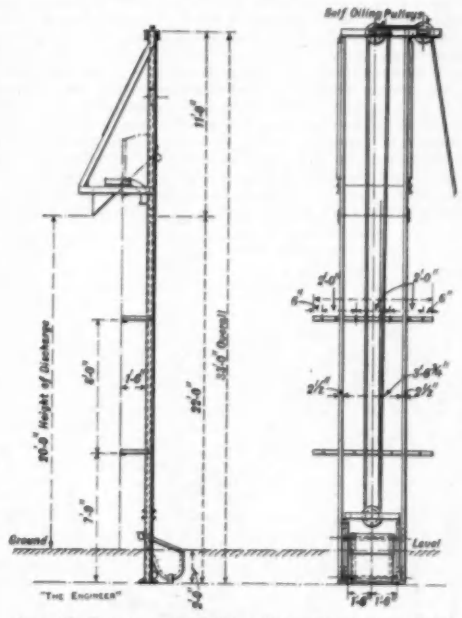


Fig. 13—Builders' Hoist—Stothert and Pitt

increase the height, new sections are added at the bottom and the whole structure raised by means of tackle and a couple of poles at the top. The skip has two pairs of wheels, one of which runs inside the vertical channels and the other behind. Near the top of the tower curved guide channels are fixed behind the verticals to catch the top wheels and tip out the contents of the skip.

Other Exhibits.

Among the other exhibitors there were G. A. Harvey and Co. (London), Ltd., of Woolwich-road, London, S.E. 7, with a fine display of perforated metal and woven wire, including some very handsome window guards; Allen-Liversidge, Ltd., of Victoria Station House, Westminster, had some dissolved-acetylene flare lights and oxy-acetylene welding and lead-burning outfits; the Crittall Manufacturing Company, Ltd., of Braintree, had a variety of metal-framed windows, which included one of the vertical sliding type of sash and several fly screens; the British Oxygen Company, Ltd., of Angel-road, Edmonton, London, N. 18, exhibited a variety of oxy-acetylene welding and cutting apparatus, including blow-pipes, specially suitable for working in copper; the Dominion Machinery Company, Ltd., of Hipperholme, Halifax, Yorks., showed the Super-Elliot woodworker, with which our readers are familiar, together with several other woodworking machines; the Expanded Metal Company, Ltd., of Burwood House, Caxton-street, London, S.W. 1, demonstrated the use of expanded metal for reinforcing concrete and as a lathing for supporting plaster; Lacy-Hulbert and Co., Ltd., of Boreas Works, Beddington, near Croydon, had some air compressors for working pneumatic tools and paint sprays; and the Midland Saw and Tool Company, Ltd., of 109, Summer-lane, Birmingham, showed the Midsaw universal woodworker, which we have described in connection with other Exhibitions.

A New Automatic High-speed Brick-making Process.

On the stands of the Cement Marketing Company, Ltd., Heat and Sound Insulation, Ltd., and J. Freeman, Son and Co., Ltd., at the Building Exhibition, recently held at Olympia, some interesting examples of plain and multi-coloured sand-cement bricks, made by the Vimax Machinery Company, Ltd., of Imrie House, 33–36, King William-street, London, E.C. 4, and Merstham, Surrey, were shown. We recently had an opportunity of inspecting the company's brick-making plant at Merstham, and in what follows, we give an account of the process followed and a description of the "Vimax" patented brick machine, which has a designed capacity up to 2400 bricks per hour.

The Merstham Works.

For the purpose of manufacturing "Vimax" bricks at the Nutfield-road works of the firm at South Merstham, a good quality Portland cement, combined with sharp sand taken from the adjacent outcrop of the Folkestone beds, is employed. The sand is purchased from a neighbouring pit, where it lies below 30ft. of water. It is pumped up and is delivered direct to the company's self-draining bins, which are arranged at the back of the machine house.

On page 370, in Figs. 1 to 4, we reproduce views of the works, which show the stacking and setting sheds and the two brick machines with their accompanying sand and cement mixers. The cement is delivered into a store alongside the machine house, which is situated in the centre of the works. In this room there is an electrically-driven ball mill, which is used to incorporate the finely ground mineral oxide pigments with the cement when making coloured bricks. As regards the cement, that complying with an ordinary building specification can readily be used, while, for the sand, any that is clean and free from organic matter and colloidal iron or ferric hydroxide, and containing not more than 3 per cent. of clay matter, is suitable. It may vary in size between 4 and 120 mesh, but the best results are obtained with a sharp graded sand which passes 8 mesh and does not exceed 80 mesh in fineness. A mixture of 1 part of cement and 8 of sand produces a first-class facing brick capable of withstanding a crushing load of not less than 100 tons per sq. ft. at an age of 3 months. For interior and party wall bricks, mixtures of 1 : 11 may be employed, while a 1 : 4 mixture is used for bricks of engineering quality.

The cement and sand are gauged in a dry state into the sand-cement mixers, shown to the right of Fig. 4. These particular mixers serve No. 1 brick-making machine, and No. 2 machine, which has a similar mixing plant, is shown in Fig. 3. The mixers are of the "Liner" pan, or edge-runner, type, with the rollers set just clear of the bottom, so that no grinding takes place. Each of the pans has a capacity of 4 to 5 cubic feet per charge, and the two mixers which discharge into the same boot from which a bucket elevator takes its supplies, are designed to meet the full requirements of the brick machine working at a maximum output of 2400 bricks per hour. When making double-coloured bricks, each mixer delivers a different coloured charge, and the normal bucket loading and mould filling operations of the machine produce bricks with a pleasing contrast of unequal or irregular colouring. Plain-coloured bricks of various kinds are made by using a single colour, while the normal brick colour of the cement-sand brick is a greyish colour.

When the sand and cement have been well mixed in the dry state, water is added and is well incorporated in the charge until the mixture will just bind when squeezed by hand. The actual amount of water which is required for the normal good working of the machine varies with different sands and cements, but, in general, it may be taken as about 8 per cent. by weight. From the boot of the bucket elevator, seen in the centre of Fig. 4, the material is charged into the machine hopper, the mixture being delivered when the mould-filling ram is clear of the hopper mouth. The sequence of continuous operations of filling and pressing the rotating moulds, which advance 120 deg. at each stroke of the crank, and the automatic delivery of the completed bricks in threes on small trays travelling on a roller conveyor, are described in detail in the later section of our article devoted to the working of the "Vimax" machine. After leaving the machine, the bricks are visually inspected, and the loaded trays are then transferred by hand to light steel crates designed to accommodate 42 trays, or 126 bricks. The filled crates are wheeled on small lifting trucks into the setting shed, a view of which is given in Fig. 2. They remain in this shed for 24 to 48 hours, after which they become sufficiently hard to permit them to be handled, and transferred to the stacking shed. Immediately after the bricks are made, they are sprayed with water and are left in a moist condition covered with hessian cloth for several hours. This condition is maintained for about three weeks in the stacking shed, after which the bricks are ready for transport by road or rail for any distance. At the Merstham works, the setting shed is 210ft. long and 80ft. wide, with a capacity of two days' maximum output, namely, 80,000 bricks, while the covered stacking ground is 336ft. in length and 48ft. wide, and will accommodate 1,600,000 bricks.

On the occasion of our visit, we inspected a large number of various patterns of bricks, some in course of manufacture. The bricks were very uniform in quality, and we were shown standard 1 : 8 cement-sand "Vimax" bricks, which, when tested at the National Physical Laboratory, showed, at the age of three months, 108 tons per square foot crushing resistance, 144 tons at eight months, and 209 tons at eighteen months. The bricks cut easily and evenly with very little waste, and porosity tests which have been made indicate that they do not encourage condensation on the surface of inner walls. It may be of interest to note that the weight of one thousand standard "Vimax" bricks is about 2 tons 15 cwt.

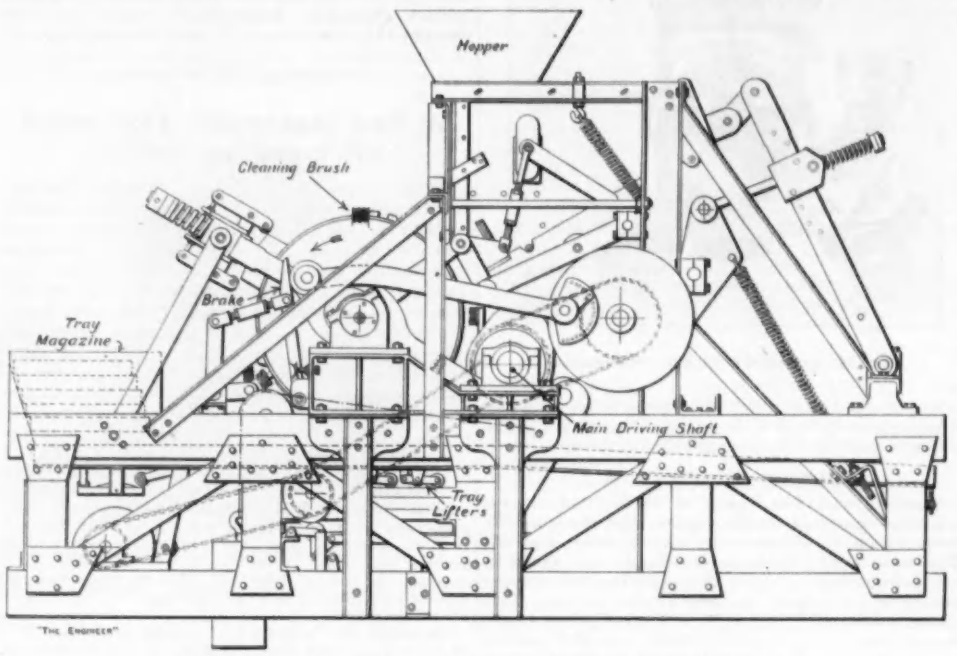


FIG. 5—SIDE ELEVATION OF "VIMAX" BRICKMAKING MACHINE

The "Vimax" Brick-making Machine.

The "Vimax" automatic high-speed brick-making machine was invented and constructed by Mr. D. G. Mackenzie, of 224, High-street, Stratford, at whose works both those above referred to were built. The Mackenzie patents have now been taken over by the Vimax Machinery Company, Ltd. The first machine was delivered in November, 1928, and after a short preliminary run was in constant operation until the end of August last, having performed successfully about eighteen months' regular service. It is still giving good results. The No. 2 machine, which embodies several improvements in construction, was recently delivered and has now been set to work. The two machines are shown in Figs. 3 and 4, while in Fig. 5 we reproduce a side elevation arrangement of the later machine, and in Fig. 6 details of the mould rotor. As will be seen from the engravings, the main frame of the machine is robustly built up of angles, channels and plates, which are riveted together longitudinally; but for purposes of assembly are secured by bolts to the transverse members. Each machine is erected over a pit which gives easy access to all underneath parts. For the driving of the factory, including the machines and mixers, a 25 B.H.P. motor is used, and when operating at normal output each machine requires about 6 B.H.P. The main drive is taken from a line shaft and is transmitted through a Ferodo-lined friction clutch operated by a handle on the machine platform, to the main driving shaft at the centre of the machine. All drives are by roller chains with jockey pulleys, and the main bearings are of the plain phosphor-bronze shell type, while ball bearings are used on all the smaller shafts. The main driving shaft also carries the cams which work the press head, and from this shaft there is taken the auxiliary roller chain drive for the tray feeding gear, the tray lifters, and the main drive for the crank disc shaft from which the hopper feeding ram is worked. As shown in Fig. 5, the connecting-rods which drive the mould rotor are attached to the crank discs by an adjustable arrangement for the crank pins which enables the throw of the rods to be slightly altered if necessary to take up wear.

We will now deal with the consecutive motions of the machine from the delivery of the cement-sand mixture to the hopper to the discharge of the finished brick on the roller conveyor. As previously mentioned, the bucket conveyor is timed to deliver a charge of mixture into the hopper the moment the filling ram is advancing, and the hopper door opening. The ram, which will be seen to the right of Fig. 6, is furnished with a floating head comprising a ball and socket and spring joint with the object of assisting the consolidation of the mould in the event of the material being unequally distributed at the beginning of the ram stroke. The ram is guided along the inclined base of the hopper by rollers which engage with guides above it, the guides being held at their lower ends by rods carrying turnbuckles, while the upper ends are attached to links mounted on excentric bushes so that adjustment in case of wear is allowed for. As will be seen from Fig. 5, the filling ram is actuated by rocker arms. They are shown to the right of the drawing, and also in the view on the left of Fig. 3. These arms are connected through spring-balanced rods to the upper part of two triangular-shaped brackets carried on an auxiliary cross shaft. The brackets carry rollers which engage with the actuating cams on the crank disc shaft, the rollers being maintained on the cam profiles by long adjustable springs. During the filling operation an impact pressure of 1¼ tons is exerted by the ram.

In order to fill the mould without loss of material the door of the hopper is made to follow the curve of the mould face as it rotates past the mouth of the hopper, and this concentric motion is obtained by the combined action of a hinged link and a radius rod. The lever controlling the door is shown immediately above the connecting-rod in Fig. 5. Drawing Fig. 6 illustrates the arrangement of moulds in the rotor, a vertical section being shown to the left of this figure and two consecutive positions of the rotor to the right. The moulds are carried on a three-arm cast steel spider which is mounted at the centre of the rotor shaft and the bottom plates of the mould upon which the firm's registered trade mark is embossed are attached to the ends of the arms. The two sides and two ends of the mould are bolted to each other, and they are guided by shoes attached to the end plates which engage with a series of eight guide rollers so grouped that three rollers are always in contact with the shoes no matter what position the mould is in. As will be seen from the lower section to the left of Fig. 6, the end plates are extended inwards towards the centre of the rotor and an axle passes through them which carries at its ends rollers travelling in the cam path. The rollers and cam paths are shown dotted in the two views to the right of Fig. 6. Both the cam plates and the discs to which the guide rollers are attached are covered by a casing which turns with the rotor, while each roller disc carries three pawls which engage with ratchet teeth cut in the periphery of the cam plates.

Other features of the rotor construction are the outside lugs for positioning the rotor, which is securely held by a roller mounted on the locking lever shown to the right in Fig. 6. There is also an ingenious arrangement of cleaning brushes for the frog plate on the press head, and the mould bottoms, which brushes are advanced and retarded by links attached to the moulds opposite to them. The rotor is also furnished with a band brake operated by link gear, the brake bringing the rotor quickly to rest in the desired position before being locked. As may be gathered from Fig. 5, the rotation of the crank discs and the connecting-rods impart to the rotor shaft a reciprocating motion. On the outward or anti-clockwise stroke of the rods, the pawls on the cam plates are engaged and the rotor along with the cam plates moves forward 120 deg., while on the return stroke the pawls slip and the cam plates alone move, altering the positions of the sides of the mould, as indicated in Fig. 6. In position No. 1, the crank arm is shown in its forward position, and the right-hand mould is coming upwards for the filling operation, the left-hand mould is about to be pressed, while the pressed brick in the bottom mould is ready to be delivered on to the tray. In position No 2, the crank arm is in its return or right-hand position, and the brick has been delivered on the tray by withdrawing the mould sides, while the right-hand mould is being filled, the mould under the press head having been consolidated by applying a pressure of about 5 tons, the sides of the mould being slightly withdrawn to leave the frog face of the brick clear for delivery on to the tray. These operations are repeated after the crank has returned to its original position, and the rotor which is ready to revolve has again moved forward. The press head is mounted on a swinging arm, shown to the left of Fig. 5, and is connected to two lower roller levers by rods which are enlarged at their centre, and provided with slots, so that they clear the rotor shaft which passes through them. The rods are halved at the yokes and secured by bolts, which facilitates assembly.

In the lower part of the two right-hand views shown in Fig. 6, we indicate the arrangement of tray lifters, which assist in carrying forward the trays with the finished bricks on them until they reach the inclined roller conveyor. As shown in Fig. 5, the magazine at the left-hand end of the machine holds five trays, which drop in turn on to the carriage, and are moved forward by a pawl which engages with pressed indentations in the bottoms of the trays. The pawl is worked from a cam and roller, and horizontal motion is obtained by allowing the back end of the pawl to move over a curved block. On the first stroke the front end of the tray passes on to the first of four lifting rollers, which are provided with counterbalanced arms, the weight on the first roller being just sufficient to allow it to lift the end of the empty tray. During the next forward movement, the tray passes on to the second roller, which is so balanced that it supports the weight of the tray and the first brick to be delivered. The third roller supports the weight of the tray and two bricks, and the fourth roller three bricks. At the moment of delivery, the brick is lightly held between the bottom of the mould and the tray, while the mould sides are withdrawn. As shown in Fig. 6, there is a horizontal frame below the roller arms, the function of which is to lift the tray during the forward movement and to lower it for the delivery of each brick, a level track being maintained for the forward feeding of the trays.

The firm has recently established a research laboratory at Merstham with a view to testing the suitability of various sands and industrial by-products, such as china clay waste, slags, and shales, for the purpose of making "Vimax" bricks.

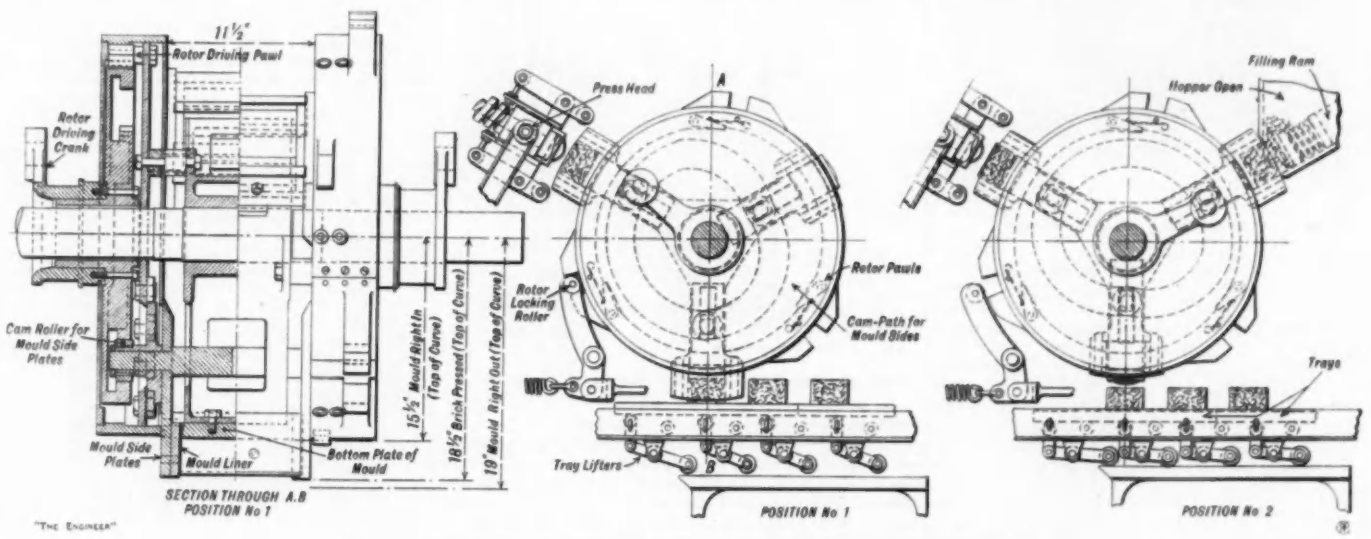


FIG. 6—ARRANGEMENT OF MOULD ROTOR OF BRICKMAKING MACHINE

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

No Improvement.

It is regrettable at the beginning of October to have to lament the absence of any signs of an improvement in trade even such as is normally to be expected with the advent of autumn. Iron and steelmasters, engineers, manufacturers and, indeed, all those gathered on 'Change in Birmingham this week stated that they were unable to see anything which was definitely favourable to an early revival of business. This abnormal market quietude is becoming unbearable, and the general unsatisfactory state of order books is a matter of serious concern. Buying is of a sullen character and does not embrace a single ton more material than is actually required for immediate consumption. Specifications are difficult to obtain in all departments, and few, if any, new contracts are being made. The iron and steel-consuming industries in the Midlands are no better employed than they were, and in most branches dull conditions rule. General engineers and constructional engineering firms are quiet, but the electrical trades continue fairly well situated. Automobile engineering should show progress within the next month.

Pig Iron Prices.

It had been pretty generally foreseen that no alteration in the official minimum selling rates for pig iron would be made by Midland blast-furnacemen. It was evident after last week's meeting of the executive of the Central Pig Iron Producers' Association that smelters held the opinion that price reductions in the present conditions of the market would be of no avail in stimulating demand. Moreover, although consumers assert that prices are too high, they are not prepared to declare that the market would respond to price concessions. Most of the iron foundries in this district are short of work, as are the forges, and the statement made by some blast-furnacemen that their turnover has improved does not carry conviction. The business transacted this week was for very small tonnages, chiefly for foundry material. Prices are unchanged, Derbyshire and North Staffordshire No. 3 foundry iron being £3 13s. 6d. and Northamptonshire £3 10s. Forge material is 5s. per ton less in each case. Producers of blast-furnace coke this week endeavoured to get 13s. per ton at ovens for coke, but there is little evidence that this figure has been paid. Ovenmen's attitude towards selling values is certainly stiffer, however.

Steel.

Demand for steel shows no improvement, either in the finished or semi-finished branches. Structural engineers have few contracts on hand and report considerable repression of new enterprise. Midland rolling stock firms, which usually buy large quantities of steel, are not so well employed as they were, consequently tonnages of steel being bought to-day for the construction of carriages and wagons are smaller than has been the case for some time past. Competition from the Continent in steel materials remains keen, despite the fact that foreign steel prices are now steadier. Very little business is being done in this district, most users of continental material having covered their requirements for some time ahead when prices were at their recent low levels. Continental billets are this week quoted £4 10s. upwards, steel bars £5 7s. 6d., and tube strip £6 5s. Native steelmasters ask £5 15s. upwards for mild steel billets delivered. Re-rollers hereabouts are prepared to do business in small re-rolled bars at £7 12s. 6d. Staffordshire hoops make £10 per ton at makers' works. No revision in prices of heavy steel are likely before the meeting of the associated steel manufacturers, which is due to take place towards the end of the month. It is hardly known at present what attitude steel manufacturers are likely to take up at that meeting regarding prices, but users are carefully looking for signs, and as the days go by increased interest will be manifested in the gathering. The steel works continue to refrain from purchasing scrap. They are well stocked.

Staffordshire Wrought Iron.

There is no change in trading conditions in the Staffordshire wrought iron industry. Business is quiet and unevenly distributed and there is a decided scarcity of new orders. Prices stand at £12 10s. for marked bars, £10 to £10 5s. for Crown iron, £9 upwards for nut and bolt bars, and £11 2s. 6d. for iron tube strip. It is only with difficulty that plant is kept in operation, and were it not for the best bar and strip branches there would be practically no activity in the Staffordshire finished iron trade at date.

Sheets.

Overseas buyers of galvanised sheets have not yet responded to the substantial reduction in price recently made with the express intention of soliciting this class of business. Inquiries have been more numerous, but orders continue scarce. Galvanised corrugated sheets of 24-gauge at £11 12s. 6d. per ton are considered to be cheap enough to attract business and rollers are at a loss to understand why buyers continue to withhold orders. The reduction of 1s. in the Association price for tin-plates—from 18s. to 17s. per basis box f.o.b. works port—has not stimulated local demand. This is probably accounted for by the fact that before the reduction merchants were accepting business at this figure.

Blast-furnace Closes Down.

A blast-furnace at Priorslee, near Shifnal, Shropshire, closed down on Saturday last. Some 150 men are affected. As showing the state of the market, it is reported that at this furnace alone there are 16,000 tons of pig iron in stock.

Railway Orders.

Further orders for rolling stock for overseas railways have just been received in Birmingham. The Metropolitan Cammell Carriage, Wagon and Finance Company, Ltd., Birmingham, is to supply the Soudan Government Railways with 50 four-wheeled all-steel covered goods wagons and 50 four-wheeled hinged sided all-steel wagons. Fielding and Platt, Ltd., of Gloucester, have been awarded a contract for a new 20-ton wagon coaling hoist by the Great Western Railway. Recent steel bridge work orders given out on account of the Union of South Africa Railways include a 150ft. through span for the Tugela River bridge, to the Patent Shaft and Axletree Company, Ltd., Wednesbury.

Development Schemes.

Unemployment schemes involving an expenditure of £90,000 have been approved by the Wolverhampton Town Council, subject to maximum grants being received from the Unemployment Grants Committee. One of the principal works is rural development by the Electricity Committee at a cost of £27,500. Non-revenue producing schemes account for an expenditure of £52,000 and represent some ten weeks' work for 900 men.

Unemployment.

Another increase in the number of workless in the Midlands is shown by the latest returns. The present total of 291,157 is an advance of 3424 on the previous week and is higher by 137,356 than in the corresponding week a year ago. The Birmingham area, on the week, showed a slight decline to 51,305, while a similar fall at Coventry brought the total there to 11,226. The employment position was slightly better in the Stoke-on-Trent area, and at Wolverhampton, but was worse at Leicester and Northampton. Some Black Country towns varied one way and others in the opposite direction.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Road Transport and the Heavy Oil Engine.

LANCASHIRE firms are playing a prominent part in the development of the heavy oil engine for road transport of both passengers and goods, the engine being the design of L. Gardner and Sons, Ltd., of Patricroft, near Manchester. Other firms—Crossley Motors, Ltd., of Gorton, Manchester, and Walker Brothers, Pagefield Works, Wigan—have closely collaborated in the work, which may now be said to have reached the practical stage. What is claimed to be the first all-British double-decker motor omnibus of its type to be driven by a crude oil engine has been delivered to Leeds Corporation. The engine is of 80 H.P., with six cylinders, and is the product of Messrs. Gardner, the chassis and body having been built by Crossley Motors. Marked economies in running expenses have resulted from extensive road tests, in the case both of the passenger vehicle referred to and of the commercial lorry. The latter has a capacity of 5 to 6 tons, and is equipped with a four-cylinder Gardner cold-starting engine of 42 H.P., made by Walker Brothers. The firms concerned have orders in hand for other vehicles of similar types and important developments are looked for in the near future.

Reorganising Cotton Mills.

Lancashire textile machinery makers have for a long time been faced with unsatisfactory markets, and the position during the past twelve months has taken a turn for the worse by reason of the fact that almost all the overseas markets have been placing orders in steadily diminishing quantities. No general improvement of the situation has occurred, although textile machinists have secured some slight benefit through the activities of the Lancashire Cotton Corporation, a body which controls a large number of cotton mills in this area. Reorganisation and modernisation on a large scale have already been carried out, and it is now officially announced by the Corporation that considerable expenditure has been sanctioned for the reorganisation of twenty other mills. A large portion of the equipment needs will probably be met by re-arranging and transferring existing plant, but welcome orders should also come the way of Lancashire engineering firms in this branch.

Work on the Ribble Estuary.

Preston Town Council is considering a scheme, estimated to cost about £110,000, to continue for a mile and a half the training walls in the Ribble estuary, and the requisite parliamentary powers are being sought. If the scheme is carried through it will mean the completion of the work of straightening the channel from the port of Preston to the Lancashire coast.

Business Notice.

The official announcement is made that Mr. Arthur Brampton, chairman, and Messrs. F. W. Fell Clark and Normal Hill have resigned from the board of directors of the Coventry Chain Company, Ltd., Coventry, and that Mr. Charles W. Goff has been appointed chairman and has been elected to the board of Hans Renold, Ltd., Burnage, Manchester, whilst Mr. Charles G. Renold, chairman of Hans Renold, has been elected to the board of the Coventry Chain Company. It will be recalled that the two concerns were recently the subject of a merging of interests.

Non-ferrous Metals.

From the point of view of market strength, the non-ferrous metals have just passed through one of their blackest weeks, for in every section declines have been on a much bigger scale generally than for a long time. The view that prices had touched rock bottom has been repeatedly expressed, but just as often calculations have been rudely upset by fresh weakness. The consequence is that the trade demand for most of the metals is on a much reduced scale, for the consumers of the finished articles are equally cautious in the extent of their commitments. In spite of the restricted production supplies relative to demand are excessive in almost all sections, and this factor continues to operate against stability. There is no necessity to go back long before the war to find prices parallel to those now ruling. The extent of the slide is more readily realised if one goes back no further than the beginning of the present year. On balance for the week, standard copper is lower by nearly £2 a ton, tin by from £6 10s. to £7, spelter by about 15s., and lead by about £1. Compared with quotations early in January, current values represent declines of nearly £30 a ton in the case of copper, £50 in tin, about £4 10s. in spelter, and nearly £5 in lead. One may justly echo the fervent expression of many that "surely they cannot continue to fall indefinitely." The one thing that becomes more and more certain is that until there is a definite turn in the price tide, the possibility of a recovery in the non-ferrous metals industries is remote.

Iron and Steel.

Interest in pig iron has been a trifle less dull now that values of Midland brands are assured for another month, but there has been no expansion of forward buying, and the very moderate trade that is going through is for the most part for prompt or early delivery, with few users disposed to venture any further ahead than the end of the present month. Current quotations are at 72s. per ton for both Derbyshire and Staffordshire varieties of foundry iron, with forge iron at 67s., Scottish pig iron at about 92s. 6d., and West Coast brands of hematite at from 85s. to 86s. per ton, all delivered equal to Manchester. Demand for bar iron of any weight is equally lacking, although there is no disposition among makers to alter prices, Lancashire Crown bars being maintained at £10 5s. per ton and No. 2 quality at about £8 15s. Steel users in most sections of the market are showing little confidence in current quotations, and in the belief that the next week or two will witness a scaling down of the scheduled rates new buying is strictly of a hand-to-mouth nature, with, however, a disappointing decline also in the rate at which steel is being taken into consumption against existing commitments. This applies to almost every branch of the consuming industries in Lancashire. Small re-rolled bars are easy in tendency at about £7 12s. 6d. per ton and boiler plates at £9 12s. 6d., but otherwise prices are unchanged.

Manchester Association of Engineers.

The syllabus of the Manchester Association of Engineers for the forthcoming session, which opens on the 10th inst., contains many interesting features, and the papers to be submitted for discussion cover a wide field. On the opening night, in accordance with custom, the President, Mr. George E. Windeler, M.I. Mech. E., will deliver his presidential address, which will be followed by a smoking concert. On October 24th, Mr. Julius Frith, M.Sc., and Mr. F. Buckingham, B.Sc., will read a paper on "Stored Energy"; on November 6th the members will be the guests of the North-Western Branch of the Institution of Mechanical Engineers, when a paper will be read by Mr. K. Baumann, entitled "Some Considerations in the Development of the Steam Cycle"; on November 28th, Mr. F. Rowe, B.Sc., will read a paper on the "Selection and Treatment of Materials for Gears"; on December 9th, Mr. E. Ivor David, M.I. Mech. E., will read a paper before the Institute of Fuels on "Local Electrical Power Generation *v.* the Grid," to which members of the Manchester Association of Engineers are invited; on December 12th, a reception and dance is to be held at the College of Technology; on January 9th, Mr. J. M. Heyes will present a paper on the "Design and Construction of Artificial Silk Machinery"; on January 27th, the members will be the guests of the local branch of the Institution of Electrical Engineers; on February 13th, Mr. C. H. Faris, A.M.I. Mech. E., is to read a paper on the "Applications of Electro-deposited Metal to Engineering"; the annual dinner will be held at the Midland Hotel on Friday, February 20th. On March 13th, Dr. G. E. K. Blythe, A.M.I.E.E., is to read a paper on "The Industrial Application of Pulverised Fuel"; and on March 27th, Mr. W. H. Poole will read a paper entitled "Developments in Modern Foundry Practice." An equally instructive syllabus has been prepared for the Student Members' Section.

BARROW-IN-FURNESS.

Hematite Slump.

There is only one word which correctly describes the state of the hematite pig iron market at present, and that is "slump." Trade is exceedingly flat, and there is not a customer who is taking heavy deliveries. All orders are to meet present needs, which everywhere seem to be meagre. There are nine furnaces in blast, but they are not at full output, alternate blasts having been introduced where two are working. Stocks are uncomfortably high, and there will have to be further restrictions unless business improves in the early future, and at the moment there is no sign of improvement. What makes the position worse is the fact that both rail mills in the district are idle, and that means that the local demand for iron is down as low as it can be. Continental and American business is the same—small orders, which are not being received with the frequency which was experienced some months ago. The iron ore trade is flat, both on local and outside account, and imports of foreign ore are on a small scale. The steel trade is exceedingly quiet, and there are no orders to report. There are still hopes which were awakened by the rumoured Canadian report of 50,000 tons being needed, but nothing has been announced yet, even as to inquiries. The hoop and small section mills at Barrow have orders and are moderately employed.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Position.

There is a general feeling in Sheffield that trade during August was at as low an ebb as anybody can recollect. There is a feeling that the bottom of the depression ought to have been touched by this time, and that an improvement should manifest itself soon. Some slight signs of an upward tendency have been discerned in certain directions, but there is no real evidence of a revival yet, and in some sections of industry September was even worse than August. The open-hearth steel department is still in the unsatisfactory position that it has occupied for a considerable time. The number of furnaces in operation continues to be about one-fourth of the equipment of the district, and, even on this scale, there is scarcely enough work coming in to keep them engaged. There is much idle plant at the works of the United Steel Companies at Templeborough, Ickles, and Stocksbridge, while other large establishments are finding conditions far from good. The Park Gate Iron and Steel Company, after enjoying full operation for several years, has recently found it necessary to curtail production, and the prospects are not cheering. The trade in crude heavy steel has, in fact, reached such a low level that it is difficult to cover overhead charges, and profit-making is, in most cases, out of the question. The relief afforded by de-rating has proved exceptionally valuable in these difficult times.

Railway and Shipbuilding Work.

With the shipping trade quiet, and comparatively little new tonnage being booked at the shipyards, demand for shipbuilding steel has fallen off, after a period of moderate activity. There is much shortage of railway work, alike in axles, tires and springs, and in vehicular construction. The new rolling stock programmes announced at the beginning of the year by the British railway companies are not being carried out in full, owing to the severe economies which have been found necessary. Reduced traffic means that fewer wagons are needed, and engine power is also on a smaller scale. While rolling stock is, of course, constantly wearing out, the companies do not need to build so many new wagons as they anticipated at the end of last year. There is a moderate amount of work on hand from overseas railways, but as economies are being practised by them as well as by the home companies, there is plenty of room for improvement. There is a little better tone in the shops which build wagons for private owners. Work has been almost at a standstill in this trade for quite a considerable time, owing to the large surplus of privately owned wagons. That surplus is now considerably reduced, but has not been cleared off yet, and, consequently, while the wagon works have some orders on hand, their state of employment is much below capacity.

Orders and Inquiries.

Actual orders announced during the week have been very few, but there is one good one among them, booked by the Stanton Ironworks Company, near Derby, from the Underground Railway group of London, in connection with schemes for tube railway developments. This is an order for 20,000 tons of cast iron segments, of a value understood to be about £125,000. Indian Railways are in the market for supplies on a considerable scale. The India Store Department has invited tenders for the supply of 20 locomotive engines and tenders, "Y F" type, metre gauge, and it has also recently received tenders for 13 locomotive boilers. The Bombay, Baroda and Central India Railway also requires locomotive boilers. The South Indian Railway Company is in the market for rolled steel disc wheels and axles for carriages and wagons, helical and volute springs; while railway material required by the Madras and Southern Mahratta Railway includes angles, channels, flats, plates, rounds, sheets and squares.

A Good Report from Staveley.

There were several points of much interest in the speech of Sir William Bird, chairman of the Staveley Coal and Iron Company, at the annual meeting last week. The company's profit for the year amounted to £408,167, an increase of over £100,000 on the previous year, and the dividend was raised from 5 to 6 per cent., tax free. Sir William stated that the coal trade was still in a depressed condition. During the last few months the shipping trade had been exceptionally bad, and the pits had only worked roughly 60 per cent. of their possible time. In the early part of the year the demand for pig iron was fairly good, but it had fallen away very much during the last few months, as both Indian and continental irons were making inroads into some of their markets in this country, being produced at very much lower labour cost. However, the furnaces had been continually in blast, with the exception of one which was set down two months for repairs. The business in the foundry department had been quite good in tonnage. The company had been able to obtain orders both from South America and Egypt in face of very keen competition, and the financial year commenced with a fairly good order book. The output for the past year in this department was the best on record. Business in the concrete lining of cast iron pipes was both satisfactory and expanding. They were now engaged in erecting a new plant for the manufacture of iron pipes by a centrifugal process in a sand-lined mould. He understood that pipes made by this process were finding great favour in America and Canada. Being cast in a sand mould the metal received no chill, and this, together with the centrifugal action when casting, produced a pipe of great strength, with a closeness of texture which left little to be desired. The coke ovens had been kept busily engaged, and they had had another record output. A new plant had been installed for separating the smaller sizes, which were being put on the marekt for domestic uses, and the plant was working very well.

Colliery Enterprise.

It is announced that at the Markham group of collieries of the Staveley Company, where much development work has been in progress during the past few months, the Hazel seam has now been tapped, and production is to be started at once. The coal is understood to be of first-rate quality, and it will be raised primarily for household purposes. The company contemplates the closing, in the near future, of its Hartington colliery, one of its oldest pits, which is nearing exhaustion. It considers that it will probably be better to work the remaining coal from its Ireland colliery. The question of closing has, however, been deferred for the present, and will be reviewed about six months hence.

Trade in Alloy Steels.

Sir Robert Hadfield, in an address to the Oil Industries Club in London last week, dwelt on the capacity of British steel makers to supply the special material required not only for drilling wells, but also in every stage of the pumping, transport, refining, processing and utilisation of oil. The production of alloy steels is a growing branch of local industry, and as engineers are using an increasing proportion of these materials in preference to ordinary steels, there is no doubt a good future before the trade. It is no longer a monopoly of the city, but prospects are evidently encouraging, as one large local firm is putting down plant for the development of this branch. At present, the volume of the trade is much less than it was a year ago. There are, however, good orders on hand, but they are unevenly shared among the makers. There is only a poor demand for tool steels. At the mills and forges trade is so quiet that it is difficult to maintain a three days' working week. This is principally due to the serious falling off of business with overseas markets. Current shipments of steel to India, China and Australia are lower than they have been for many years.

Cutlery and Plate.

There is a poor demand for cutlery and plate goods from general purchasers in the home market, but orders from public caterers are on a larger scale than ever. There has been a substantial fall in exports, but it is thought that this trade will revive before long, as stocks abroad must be extremely low. The scissors trade is a bright spot in the prevailing depression, and is busier than it has been for years. Modern methods of production have enabled Sheffield to offer scissors at prices competing with those of Germany, and trade is increasing both at home and abroad. Good employment is the rule with firms specialising on best quality pocket knives. The safety razor blade branch is fairly healthy. About twenty local firms are now engaged in it. Increasing attention is being paid to the production of cheap blades, and five firms are now marketing a good quality blade which can be sold retail at a penny. The output of electro-plated spoons and forks is steadily maintained, but the trade in silver ware is flat, in spite of the cheapness of raw silver.

Humber Bridge Opposition.

The great project for bridging the river Humber near Hull has not made the headway that its promoters hoped, as, although the Ministry of Transport has agreed to contribute 75 per cent. of the cost, only a few of the local authorities in the area have signified their intention of giving financial assistance. Now comes adverse criticism of the proposal from the point of view of navigation. The Goole Chamber of Commerce has passed a resolution viewing the proposed bridge with grave apprehension, and declaring that it is a serious menace to the port. The Humber Conservancy Board, at Hull, has decided to forward to the Minister of Transport a report by its engineer—Mr. A. E. Butterworth—which is very adverse to the scheme. Mr. Butterworth expresses the fear that the building of 22 piers at the site selected may cause irreparable damage to the channels both above and below, and also that there will be danger to navigation, as in hazy or foggy weather it would be difficult to make the navigation span with either confidence or safety.

Sheffield's Mission to South America.

In a cablegram—dated September 25th, from Buenos Ayres—from the Master Cutler, Mr. Arthur Kingsford Wilson, head of the Sheffield Mission to South America, he states that the potentialities for British business in South America are far greater than is realised at home. Everywhere, he continues, the Mission is being warmly welcomed, and he finds it essential to prolong his stay in the Argentine. Thus, the Mission, after visiting the other Republics, cannot arrive back in England until the middle of December.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

The Cleveland iron trade shows little signs of improvement. There is an atmosphere of pessimism abroad, which is prejudicial to business, and buyers are only disposed to cover their immediate needs. Thus the hoped-for autumn expansion has not yet developed, and business is on a very restricted scale. Export orders have virtually ceased, and foreign competition is very keen in the Scottish market. Cleveland ironmasters, however, adhere to their fixed minimum prices, No. 1 foundry being 66s.; No. 3 G.M.B., 63s. 6d.; No. 4 foundry, 62s. 6d.; and No. 4 forge, 62s.

Hematite Pig Iron.

The firmer feeling that recently entered the East Coast hematite pig iron trade is maintained, and the heavy stocks are being slightly drawn upon to meet the moderate home and export demand. Merchants have still substantial quantities to dispose of, but are no longer cutting prices. Mixed numbers are 71s., with No. 1 quality at a premium of 6d. per ton.

Ironmaking Materials.

Consumers of foreign ore continue to hold off the market. They have considerable stocks on hand, and are well bought ahead. Nominally best Rubio ore remains at 19s. c.i.f. Tees. The coke market is quiet, but 17s. is now a minimum figure for good medium blast-furnace qualities.

Manufactured Iron and Steel.

The recent cut of 5s. in the price of galvanised corrugated sheets has resulted in a few prompt orders, but the works could still handle a lot more business. Black sheets are also easier, but no other price changes have been made, though many of the works are desperately in need of orders.

The Coal Trade.

The individual position of collieries in Northumberland and Durham varies considerably. This week a few, owing largely to substantial bunker coal orders, have been able to record full working time, and they anticipate regular output during the next week or two. On the other hand, there are pits which are not nearly so well situated, and which are experiencing idle shifts. The home trade generally shows a little expansion, but producers and merchants alike find it a difficult task to secure fresh foreign business. Consumers can buy Polish coal at quite 2s. below Northumberland prices, and it is in ample supply and promptly shipped. The competition between this country and Poland for coal business in Northern Europe has become so keen that it is thought that the time is getting nearer when there will be an international coal price agreement that would put an end to a rivalry which is very damaging to the parties concerned. Poland has built up a big export business, but she is now stated to be feeling the strain of selling coal too cheaply, and seems anxious to come to some arrangement as to minimum prices. Inseparable from any possible agreement of the kind there would doubtless be the question of the allocation of markets as between this country and Poland, and the latter would probably base her claim on her present connections. That might involve the withdrawal by this country from certain markets, in which, prior to the national coal stoppage of 1926, we predominated. All the same, it does seem absurd that large State railway undertakings in Northern Europe should repeatedly secure their coal at ruinously cut prices because of the unchecked competition between this country and Poland.

The Outlook.

In neither of the two counties can the outlook be said to be encouraging. There is little animation in any section. The October demand so far is disappointing, while actual business is meagre, the few transactions passing being mainly through second-hand holders who have to clear their high-priced coal under present market conditions, which means at substantial discounts on the minimum fixed values. Best Northumberland steam coals are still quoted at 13s. 6d. and small at 10s. The advent of the colder weather has had no effect on the demand for any class of gas coal. Ample supplies are available, and on offer at unchanged prices. Best Durham qualities are at 15s., and secondary qualities 12s. 6d. Coking unscreened are also a neglected trade, and quoted easy at 12s. 6d. to 13s. For bunkers the demand is improving, and superior kinds command 13s. 6d. and good seconds 12s. 6d. Trading remains sluggish in all sections for coke, and patent oven stocks continue to grow. Neither prompt nor forward demand shows any animation. Prices hold easy for prompt clearance, but quietly steady forward at 17s. 6d. to 18s. Beehive and superior coke is steady at 24s. to 28s., the production being kept down to orders on hand.

Improving Economically.

That the Northumberland coal trade is improving economically, though the output has decreased, is apparent from the report of the accountants on the proceeds and costs for August. It shows that for the first time for three months a trading profit accrued. Though this amounted to only £5046, it is better than the deficiencies of £14,000 and £15,000 in June and July respectively. The advance in the month is shown by the ascertainment figure, which is 19·72 per cent. compared with 10·52 per cent. for July. This means that but for the minimum wage clause stipulating that wages shall be 40 per cent. on basis rates, wages in October would be basis rates plus 19·72. In meeting the difference between these two figures, the owners have to sacrifice £34,514 of the 13 per cent. of the trading surplus, which is their due. This is shown as a deficiency, and the accumulated monthly deficiencies now stand at £2,621,682. The total proceeds of the industry during the month were £520,150, compared with £524,257 in July.

Important Contract for Armstrong-Whitworths.

As I was able briefly to record in this letter last week, Sir W. G. Armstrong, Whitworth and Co. (Engineers), Ltd., have received from the Buenos Aires Great Southern Railway Company, Ltd., an order for three oil-electric mobile power-houses, each of 1700 H.P. and one main line oil-electric locomotive of the same horse-power. Each of these units will be equipped with two 850 H.P. Sulzer locomotive-type oil engines, direct coupled to generators, and with cooling and auxiliary equipment arranged as two complete and interchangeable units carried in the one locomotive. The mobile power-houses are intended for suburban service, and each of the units will be equipped with four 100 H.P. electric motors mounted on the bogies to provide tractive power for the mobile power-houses. The remainder of the tractive effort of the train will be furnished by motors mounted on the bogies of the train in the same way as on ordinary electric suburban stock. Each mobile power-house will have one driver's compartment, while another driver's compartment will be carried on the last coach of the train unit, so that the train unit may be operated as a whole from either end.

It will be possible to operate two or more train units in multiple, as is usual with ordinary suburban electric stock. The contract is of additional interest as an indication of the success attendant upon the working of two 1200 H.P. mobile power-houses supplied some two years ago jointly by Sulzer Brothers, of Winterthur, and Sir W. G. Armstrong, Whitworth and Co. (Engineers), Ltd. It is understood that the larger units now ordered will be the future standard for this type of service on the B.A.G.S. Railway. The main line electric locomotive will be similar in design to the mobile power-house, but will have considerably heavier bogies and will carry electric motors sufficiently powerful to provide the whole of the tractive effort required to haul a train. The whole of the contract as set out above has been placed with Sir W. G. Armstrong, Whitworth and Co. (Engineers), Ltd., but the manufacturers of the electrical equipment required have, I understand, not yet been selected.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE amount of work in Clyde shipyards has been decreasing rapidly during recent months, and with a scarcity of new orders a drop in output was inevitable. During the month of September only ten vessels of 26,894 tons aggregate were launched, which marks the lowest for any month this year. Of the September output, tanker tonnage accounted for almost 80 per cent., and as that class of vessel has helped to provide work for a number of yards, it is the more regrettable that there is no demand for vessels of that type at present. Of the vessels launched last month four were of 4000 tons and over, as follows:—"Adellen," 8000 tons, oil tanker, for the Adellen Shipping Company, London; "Norfolk," 6350 tons, oil tanker, for Messrs. Johan Rasmussen and Co., Norway; "British Venture," 4700 tons, oil tanker, for the Anglo-Persian Oil Company; and the "Mary Kingsley," 4100 tons cargo motor ship, for the African Steamship Company (Elder, Dempster and Co., Ltd.), Liverpool. The orders announced during September were for vessels of small tonnage.

Steel.

Though there has been a better inquiry for steel during the past week or so, the actual volume of business does not show any material increase. Makers, however, are more hopeful, though as a rule there is only work in hand for a few days ahead. Home and export demands for heavy steel are scarce, and mills cannot be kept regularly employed. The tube trade is dull generally. Black sheets are quiet, with prices unchanged. The overseas demand for galvanised sheets is still below expectations, despite further price reductions. The new minimum basis price for 24 gauge corrugated sheets is £11 12s. 6d. per ton f.o.b., but it is said that a slightly higher figure is usually quoted for ordinary business.

Scrap.

The demand for scrap is weak and prices are unchanged as follows:—Heavy steel, 53s.; cast iron machinery, 62s. 6d. per ton.

Iron.

Specifications for bar iron continue scarce, and there is ample room for improvement in re-rolled steel bars. The latter are unchanged at £7 12s. 6d. per ton, home or export. Pig iron is steady in price, but comparatively inactive. Considerable consignments of pig iron from the Continent and India continue to arrive in this district.

Coal.

While there has been some expansion in home demands, the scarcity of export business is the dominating feature in the coal market. Apart from Lanarkshire splints and ells, almost all descriptions of fuel are more or less neglected. Considerable disappointment was felt when it was learned that of the 48,000 tons tendered for on account of the Finnish State Railways, nothing had been allocated to Scotland, despite special efforts to secure some of that business. Export business as a rule is of a day-to-day nature, and practically nothing is being done beyond October. Washed nuts are scarce, and firm in all districts. Aggregate shipments amounted to 231,691 tons, against 243,031 tons in the preceding week and 293,107 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

ON the whole, there has been no material change in the general position prevailing in the coal industry of this district. According to the Great Western Railway Company's figures for last week shipments were a shade better than for the preceding week, the figures being 535,100 tons, as compared with 526,100 tons, but still the total was below that for the corresponding period of last year, when the quantity was 573,192 tons. The tonnage situation has certainly been a trifle improved, but it is not sufficiently better to exert a marked beneficial effect upon the working of collieries. Last week ended up with there being seventeen idle tipping appliances and six steamers waiting, while the position on Monday last was that the number of idle appliances was reduced to nine, while there were five vessels waiting to load at Swansea. This shows that the pressure was rather in respect of anthracite coals. As a matter of fact, they are very well off for orders compared with steam collieries, quite a number of which were idle at the end of last week, and owing to a ready outlet for their standing stocks, were unable to make a resumption of work on Monday. The current demand for steam coals keeps within very narrow limits, and there is no indication at the moment of an appreciable broadening in the inquiry. Since last week, news has come to hand that the import duty of 3s. 5d. per ton on coal into Syria, imposed four years ago on coal other than Turkish, has been withdrawn as from December 2nd. It is understood that this applies to steam coals and anthracite beans and peas. Patent fuel is omitted, and manufacturers of this commodity are taking steps to make representations for the duty to be removed from it. Inquiries are also being made concerning the limitation of the withdrawal of the duty to anthracite beans and peas, as coalowners are naturally anxious to know whether the duty will be taken off cobbles, nuts, &c. At any rate, if the duty is taken off all coals and patent fuel, it is useless to magnify the importance of it, because, before the duty was imposed, the quantity of coal shipped to Syria from South Wales was under 30,000 tons per annum. Still the removal of any restrictions is in the right direction. With regard to the inquiry from the Egyptian State Railways for 155,000 metric tons, further details have now come to hand, which show that delivery is required at Alexandria during the first four months of 1931.

Best House Coal.

South Wales coalowners producing best grades of house coal have decided to advance the price as from 1st inst. by 1s. 6d. per ton, which brings the pithead price to 26s. 6d. per ton. No change is made in the pithead or retail prices of ordinary quality house coals.

Wage Agreement Negotiations.

A start was made on Tuesday with the negotiations for a new wage agreement to apply to the South Wales coalfield. The importance of the occasion drew practically a full attendance of members of the Conciliation Board, but the headway made towards agreement was negligible. This was not unexpected in the circumstances. The representatives of the coalowners and the workmen held separate meetings for the purpose of considering the position generally and for formulating their proposals. From what can be gathered, these were naturally conflicting, the owners' idea being to secure a reduction of the existing minimum rates, while the workmen seek to bring about an increase in wages. The result of the meeting of the two parties was that it was agreed that a small joint committee should be appointed to consider the situation, and the future possibilities in relation to the wages and condition of employment. From this the conclusion is drawn that hopes of a settlement are fairly bright, but doubtless a number of meetings will be necessary before this is eventually achieved.

Iron and Steel and Tin-plate Trades.

The Briton Ferry Steel Works were closed down on Saturday last for an indefinite period, and a number of the men and officials are being transferred to the Albion Steel Works, which belong to the same company, and where two new furnaces have been erected. Reference has already been made to the fact that the workmen at the Dowlais Iron and Steel Works at Merthyr received notices on September 12th terminating their contracts in twenty-eight days, after which they would be employed on day-to-day contracts. The prospect of the works being continued in operation after the expiration of the twenty-eight days is not bright, inasmuch as the Merthyr Corporation received a letter last week with reference to the terms of a contract under which water is supplied to the Dowlais Works, and in this the British (Guest, Keen, Baldwins) Iron and Steel Company, Ltd., stated with reference to the notices of dismissal, that it was a step it was loth to take, but the condition of the steel trade, especially as it concerned Dowlais, was such that it had no option at present but to close down. An important decision was arrived at last week at Swansea, when both the Welsh tin-plate manufacturers and the Siemens steel makers, meeting separately, decided to make reductions in prices. Tin-plates were reduced by 1s. per box to 17s. minimum, f.o.b. works port, and steel bars were reduced from £6 to £5 15s. per ton delivered. The reduction in tin-plates was evidently anticipated as merchants are reported to have done a fairly considerable business forward on the basis of 17s. 6d. to 17s. 9d. per box.

Coal Shipment Facilities.

With regard to the action of the Great Western Railway Company in reducing the number of tips in order to effect economies in working, a conference took place last week in London between the traders and the general manager of the company. The chief purpose of the deputation was to secure if possible the full working of the East Bute Dock, Cardiff, but the efforts were unsuccessful. The utmost that the general manager of the company would agree to was that four berths instead of three previously agreed to should operate as from Monday last. A sequel to the company's decision is that Cardiff coal tippers passed a resolution on Sunday last to tender one week's notice to the G.W.R. Company of their intention to revert from the day and night shift system to the two continuous shift system. Both the company and the traders are opposed to any such change, and have so far received no official notification of the men's proposal, which, if pursued in a constitutional manner, should come through the National Union of Railwaymen, to which organisation the tippers belong.

Current Business.

Operations from day to day in steam coals continue to be very quiet, and there is no improvement in prices which for all qualities remain at the minima. The position of collieries is very irregular. A slight improvement in the inland demand is reported, and in the case of best house coals, it is understood that the question of an increase in the pithead price is under consideration, and that there is a prospect of this increase being 2s. 6d. per ton as from the beginning of October. Patent fuel is fairly steady, and there is a moderately good demand for best coke, but pitwood is weaker on account of the irregular working of pits, prices ruling from 24s. 6d. to 25s.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE CEMENT MARKETING COMPANY, Ltd., has received an order for approximately 20,000 tons of cement for the Underground Railway extension from Finsbury Park to Cockfosters.

THE SPERRY GYROSCOPE COMPANY, Ltd., of 15, Victoria-street, London, S.W. 1, asks us to announce that Mr. Percy W. Gray, late special director of Vickers-Armstrongs, Ltd., has taken up the position of managing director of the company.

RIDSDALE AND CO., consulting metallurgists and analytical chemists, 3, Wilson-street, Middlesbrough, ask us to announce that they have recently been approved by the Air Inspection Directorate for the chemical analysis of metallic materials.

MAJOR JAMES CALDWELL, M. Inst. C.E., of 14–16, Cockspur-street, S.W. 1 (Gerrard 3930), a former managing director of Alloy Welding Processes, Ltd., has now resigned his position as chairman of that company and is leaving London on October 17th for an extended world tour.

MR. W. M. WINSTANLEY has been appointed general manager of the British General Electric Company, Ltd., of South Africa, in succession to Mr. W. B. Phelp, who was fatally injured in an accident at Pontresina, near St. Moritz, on August 10th. Mr. Winstanley was formerly chief engineer to the company.

MR. JAMES W. OWENS, who was formerly welding aide for the Bureau of Construction and Repair of the United States Navy, has resigned his position as Director of Welding at the Newport News Shipyard to become associated with the Welding Engineering and Research Corporation, 25, West 43rd-street, New York, N.Y., as its Director of Engineering and Secretary.

MR. CHRISTOPHER M. MARSH, B.Sc., A.M. Inst. C.E., has been appointed by the Weaver Navigation Trustees Assistant and Deputy Engineer/General Manager to the Navigation. Mr. Marsh is at present Resident Engineer in charge of all construction and maintenance work on the docks under the River Wear Commissioners, Sunderland. He will take up his new duties at the commencement of the New Year at the Trustees' Weston Point Docks.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., asks us to announce that Mr. W. Johnstone, by his own desire, will relinquish his appointment as managing director, remaining, however, on the board of directors and undertaking other important duties, with residence in London. Mr. A. T. Brotherton has been appointed a member of the board of directors with special duties as local director at Loughborough. Mr. W. Pearson has been appointed general manager of the company. Mr. E. Garcke has agreed to serve the company for another year and to assume the title and duties of chairman and managing director.

CONTRACTS.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., has secured from the G.P.O. a twelve months' contract for the supply of "Mazda" vacuum and gas-filled lamps.

LA SOCIETE D'EXPLOITATION DES PROCEDES DABEG, of Paris, has received from the Paris-Lyons-Mediterranean Railway an order for the fitting out of 120 new locomotives with pumps and feed-water heaters, Dabeg type.

SUPER-LANCASHIRE BOILER.—We are asked to say that the air heater for the super-Lancashire boiler described in our issue of September 19th was made under the licence of Mr. H. Cruse, of Hyde, Cheshire.

AGRICULTURAL TRACTOR TRIALS AT ARDINGTON.—Owing to a clerical error, the photograph of a Marshall tractor which we reproduced in our last issue represented a type which was not exhibited at the Ardington demonstration. The tractor there was almost identical with that which Marshall, Sons and Co., Ltd., Gainsborough, sent to the Royal Show at Manchester and which was illustrated and described in our issue of July 4th.

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.—The new session in the Faculty of Engineering begins on Monday, October 6th. Students will be received on Monday and Tuesday, October 6th and 7th, from 10 a.m. to 1 p.m. Mr. A. W. T. Boyd, B.Sc., has been appointed Demonstrator in the Department of Electrical Engineering. The list of the public and special lectures arranged for the first term may be obtained on application to the Secretary, University College, London (Gower-street), W.C. 1. A stamped addressed envelope should be enclosed.

THE ENGINEERING GOLFING SOCIETY.—The autumn meeting of the Engineering Golfing Society was held at Burhill on Wednesday, October 1st. In the morning there was an eighteen-hole medal round, and the "Hele-Shaw" Scratch Challenge Cup and Memento were won by Sq.-Ldr. C. H. Hayward, with a score of 78. The handicap resulted as follows:—First Division—handicaps of 10 and under—the "F. J. Walker" Challenge Cup and Memento, A. McKinstry, 79—4=75; second prize, H. J. Taylor, 83—7=76; the "P. B. Brown" Challenge Cup and Memento were won by K. W. Macnee, with 95—17=78; second prize going to E. C. Stevens, with 96—14=82. Prizes for the best first and second nine holes were taken by A. P. Patey and P. V. Hunter respectively. In the afternoon there was an eighteen-hole round, foursomes against bogey, when the "Hadfield" Challenge Cups and Mementoes were won by Gilbert Allom and K. W. Macnee, with 1 up; the second prizes going to C. Stewart and H. P. Allison, with all square. There were forty competitors.

A FAMOUS WATER WHEEL.—Heavy floods which created untold havoc in the Isle of Man two weeks ago have caused damage to the structure surrounding the famous Laxey Wheel, as a result of which it is possible that the wheel will never work again. Apart from its interest to tourists, because of its immense size, Laxey Wheel is an interesting specimen of engineering. It is stated to be the largest water wheel in the world, and it was built in 1854 by a Mr. Casement, a young engineer of the village of Laxey. The purpose of the wheel is to operate the pumps which free the Laxey lead mines from water, and the accuracy of its balance and efficiency of working have been demonstrated for nearly eighty years. The circumference of the wheel is 226ft., its width 6ft., the number of spokes 48, and the number of buckets 188. It is operated by water conveyed through pipes from a reservoir in the hills above, which ascends a tower of 80ft., and falls upon the buckets. Upon the top of the wheel is a platform, access to which is obtained by a spiral staircase round the water tower. The wheel makes two revolutions per minute, and the pumping roads are carried on rollers for 200 yards to the main shaft, where, from a depth of 1800ft., 250 gallons of water are raised per minute. The floods carried away four of the massive arches supporting the piping, and it is doubtful whether the cost that would be necessary to reconstruct them would be warranted, in which case the wheel would be rendered inoperative.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	17/9 to 20/6
(1) Spanish	20/6 to 21/–
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	19/–

PIG IRON.

	Home. £ s. d.	Export £ s. d.
(2) Scotland—		
Hematite	3 18 0	—
No. 1 Foundry	3 19 0	—
No. 3 Foundry	3 16 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 11 0	3 11 0
No. 1	3 11 6	3 11 6
Cleveland—		
No. 1	3 6 0	3 6 0
Siliceous Iron	3 6 0	3 6 0
No. 3 G.M.B.	3 3 6	3 3 6
No. 4 Foundry	3 2 6	3 2 6
No. 4 Forge	3 2 0	3 2 0
Mottled	3 1 6	3 1 6
White	3 1 6	3 1 6
Midlands—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 8 6	—
„ „ Foundry	3 13 6	—
(c) Northampton—		
Foundry No. 3	3 10 0	—
Forge	3 5 0	—
Derbyshire—		
No. 3 Foundry	3 13 6	—
Forge	3 8 6	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 3 6 (a) / 4 5 6 (b) / 4 10 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
Lancs.—		
Crown Bars	10 5 0	—
Second Quality Bars	8 15 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	10 5 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ¼in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	8 15 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	11 17 6	11 12 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 12 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 12 6	—
Sheffield—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 10 0	—
Hoops	10 5 0	—
Soft Wire Rods	8 0 0	—
Midlands—		
Small Rolled Bars	7 12 6 to 8 10 0	—
Billets and Sheet Bars	5 15 0 to 6 5 0	—
Galv. Sheets, f.o.b. L'pool	11 12 6	—
(2) Staffordshire Hoops	10 0 0	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	17/– to 17/6
Block Tin (cash)	125 5 0
„ (three months)	126 15 0
Copper (cash)	43 10 0
„ (three months)	43 8 9
Spanish Lead (cash)	16 15 0
„ „ (three months)	16 10 0
Spelter (cash)	14 15 0
„ (three months)	14 7 6
Manchester—	
Copper, Best Selected Ingots	47 10 0
„ Electrolytic	48 0 0
„ Strong Sheets	75 0 0
„ Tubes (Basis Price), lb.	0 0 11¼
Brass Tubes (Basis Price), lb.	0 0 10¼
„ Condenser, lb.	0 1 0¼
Lead, English	18 5 0
„ Foreign	16 10 0
Spelter	15 2 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/6 per lb.	
Ferro Tungsten	2/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 5 6	7/–
„ „ 6 p.c. to 8 p.c.	£22 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£22 0 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£23 0 0	10/–
„ „ „ 1 p.c. carbon	£28 0 0	13/–
„ „ „ 0·70 p.c. carbon	£42 0 0	14/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 15 0 for home	
„ „ „	£11 0 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– per unit	
„ „ 75 p.c.	£18 0 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	11d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	12/6
„ „ Ell	13/6
„ „ Splint	14/3 to 16/–
„ „ Trebles	13/–
„ „ Doubles	12/6 to 13/–
„ „ Singles	11/9
Ayrshire—	
(f.o.b. Ports)—Steam	13/–
„ „ Jewel	16/–
„ „ Trebles	13/6
Fifeshire—	
f.o.b. Methil or Burntisland—Steam	10/6 to 11/9
Screened Navigation	16/6 to 17/6
Trebles	13/6 to 15/–
Doubles	13/– to 13/6
Singles	11/3
Lothians—	
(f.o.b. Leith)—Best Steam	11/–
Secondary Steam	10/9
Trebles	13/–
Doubles	12/6
Singles	11/6

ENGLAND.

(3) N.W. Coast—	
Steams	20/6 to 21/–
Household	32/6 to 53/6
Coke	21/– to 22/–
Northumberland—	
Best Steams	13/6
Second Steams	12/–
Steam Smalls	10/– to 10/6
Unscreened	12/6
Household	25/– to 37/–
Durham—	
Best Gas	14/9 to 15/–
Second	12/9 to 13/–
Household	25/– to 37/–
Foundry Coke	24/– to 26/–

Sheffield—	Inland.	
Best Hand-picked Branch	24/– to 25/6	—
Derbyshire Best Bright House	19/– to 21/–	—
Best House Coal	18/– to 19/6	—
Screened House Coal	16/– to 17/–	—
„ „ Nuts	14/– to 16/–	—
Yorkshire Hards	14/– to 15/6	—
Derbyshire Hards	14/– to 15/6	—
Rough Slacks	8/6 to 9/–	—
Nutty Slacks	7/– to 8/–	—
Smalls	3/– to 5/–	—
Blast-furnace Coke (Inland)	12/6 on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b. 17/– to 18/6		

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	20/–
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 18/9
Ordinary Dry Large	17/6 to 18/–
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/– to 18/3
Best Eastern Valley Large	17/9 to 18/–
Ordinary Eastern Valley Large	17/6 to 17/–
Best Steam Smalls	13/6 to 13/9
Ordinary Smalls	11/6 to 12/9
Washed Nuts	19/– to 22/–
No. 3 Rhondda Large	20/– to 20/6
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	16/– to 16/6
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	27/6 to 37/–
Furnace Coke (Export)	21/– to 21/6
Patent Fuel	22/–
Pitwood (ex ship)	24/6 to 25/3
Swansea—	
Anthracite Coals:	
Best Big Vein Large	35/– to 37/6
Seconds	27/– to 31/6
Red Vein	23/6 to 27/–
Machine-made Cobbles	41/6 to 45/–
Nuts	40/– to 46/–
Beans	24/6 to 27/6
Peas	21/– to 21/6
Breaker Duff	10/– to 10/6
Rubbly Culm	10/9 to 11/3
Steam Coals:	
Large	19/6 to 21/6
Seconds	18/– to 19/6
Smalls	12/– to 13/–
Cargo Through	15/6 to 16/–

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 12/6, Ordinary Ship, Bridge, and Tank Plates and Sections, 10/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(*From our Correspondent in Paris.*)

The Trade Situation.

NOTWITHSTANDING the efforts that are being made to present the situation in as favourable a light as possible, and thereby encourage consumers to buy, there is no ignoring the fact that matters are getting worse in the iron, steel, and engineering trades, and while most is made of the possible distribution of large orders for home and colonial public works when the Governments are able to vote the necessary funds for the purpose, the amount of work at present being done is steadily dwindling. There is a falling off in railway receipts and a heavy diminution of foreign trade. It is true that the situation is not so bad in this country as it is elsewhere, but that is due to the impulse given to enterprise by the utilisation of German reparation material, which started numerous undertakings that have to be completed with French material, and also to the labour supply being limited by the needs of agriculture and by the military service. So far, there has been little tendency to reduce the production of iron and steel, but it is now becoming inevitable in view of increasing stocks and the further limitation of output by the Steel Cartel. The fear of being involved in penalties for over-production is more serious now that the falling prices will render those penalties a heavy burden.

The Wagon Cartel.

The difficulties in the way of conciliating the interests of wagon builders in different countries were so great that it took a long time to settle finally the details of the Continental Wagon Builders' Union, which has been definitely constituted, with headquarters in Paris. Builders in some countries have subsidiary companies in others, and they have all their own markets, and in all countries there is so great a variation of wages and costs that the task of devising an arrangement that would give satisfaction to everyone was by no means easy. Secrecy is maintained as to how it has been done, but it appears that builders will still preserve their liberty of action to a certain extent, in the sense that customers will continue to place orders with builders who have always supplied them with rolling stock. The object of the Union is to control and develop the foreign trade and maintain prices. Presumably, the arrangement is on much the same lines as those of the steel comptoirs, and, while builders will take foreign orders at prices fixed by the Union, they must communicate them to headquarters, and if one country's quota is exceeded, the work will be passed on to another. The influence of the Union is likely to be particularly great by reason of its organisation for standardising manufacture and bringing down costs, and at the same time keeping builders informed of foreign specifications and endeavouring to induce foreign railways to adopt continental standard specifications. It proposes to go still further by creating a financial organisation which will finance foreign railways for the purchase of rolling stock. That is being done to a considerable extent in Germany, which has secured from Turkey important orders for locomotives, wagons, and permanent way material, to be paid for by bills extending over several years, these bills being discounted by German banks. The quotas for foreign trade in wagons are as follow:—Belgium, 34·6 per cent.; Germany, 28·8 per cent.; France, 13·9 per cent.; Italy, 10·5 per cent.; Czechoslovakia, 6·9 per cent.; Hungary, 2·4 per cent.; Austria, 2·2 per cent.; and Switzerland, 0·7 per cent. The only countries remaining outside the Union are Poland and Rumania. A serious difficulty lies in the competition from Great Britain, which has so far been suffering from the competition of continental builders, and British builders refuse to join the Union, because they would have to sacrifice some of their trade with the Dominions.

A Seventeenth-century Ship.

The launching at Honfleur last week of an exact replica of a seventeenth-century ship was an interesting event in modern shipbuilding. It is a brig of the Portuguese type, with the high after deck that was common in the French fleet in the time of Louis XIV. Built entirely of oak, the weight of the hull is 300 tons and the length 35 m. It was constructed by Monsieur Prentout to a model and designs preserved in the Honfleur Museum. Known as the "Izarra," the vessel was built to the order of Dr. Noël, of Buenos Aires, who will use it as a yacht. The deck and all external fittings will be faithfully reproduced from the original, but the equipment below will be entirely modern and auxiliary power will be provided by a 120 H.P. heavy-oil engine.

German Coal.

Since the withdrawal of the French from the Ruhr, which enabled coalowners in that district to dispose of their fuel in France and elsewhere as they pleased, there has been a good deal of irregularity in the distribution of German coal in this country, and the collieries in the Nord and the Pas de Calais have suffered particularly from the competition. The situation was so far serious that the French Government came to the rescue and endeavoured to arrange with the Ruhr Kohlensyndikat for the exercise of some control over the coal imports, particularly in the way of distributing the fuel so that it would not affect directly the interests of French coalowners. An arrangehas now been entered into with the German syndicate, whereby all its consignments, amounting to 100,000 tons a month, will be sent to Strasburg, and one half of that quantity will be carried on French barges on condition of freights not being above those of the German boats. In return for the concession made by the Germans, the French Government undertakes to pay the Kohlensyndikat a sum of 1·2 mark a ton of coal imported, that being put to reparations account. By thus controlling the imports of German coal, the French Government will be able to distribute the fuel where it pleases, and the French collieries will not be troubled with competition of German coal in their own markets.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

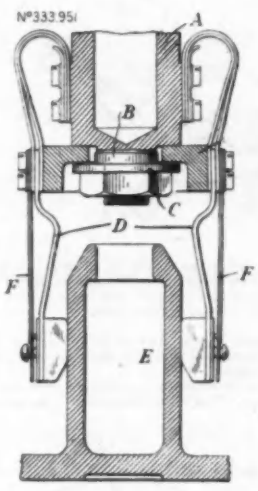
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

SWITCHGEAR.

333,951. May 28th, 1929.—CONTACTS FOR ELECTRIC CIRCUIT-BREAKERS AND THE LIKE, A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne, Durham, and John Christie, of 4, Sidecliff-road, Sunderland.

This specification describes a self-aligning contact for an electric circuit breaker, having a floating ring or collar to which are attached springing arms with contact blocks. A is a head or bushing forming one of the conductors of a circuit breaker and formed with a reduced portion or neck B, screwed to take a washer and nut C. A flanged member is placed round the

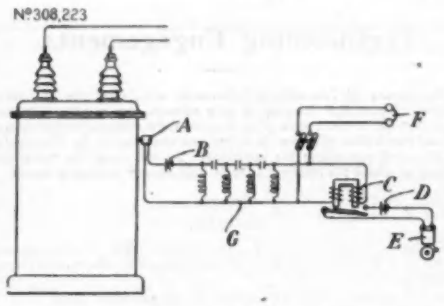


reduced portion, and has a hole sufficiently large to permit the ring to move radially in any direction. The ring carries springy metal arms D with contact blocks, which bear against the contact E. Each arm is backed by a spring F. The construction is said to provide a very efficient form of self-aligning contact for circuit breakers or parts of switchgear, in which contact members more or less axially in line have to be separated and brought together again, the floating ring enabling the whole set of contact blocks to move to a limited extent transversely to the axis of the member upon which the ring is mounted.—*August* 28th, 1930.

TRANSFORMERS AND CONVERTERS.

308,223. March 19th, 1929.—PROTECTIVE DEVICES FOR ELECTRICAL APPARATUS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.* 2.

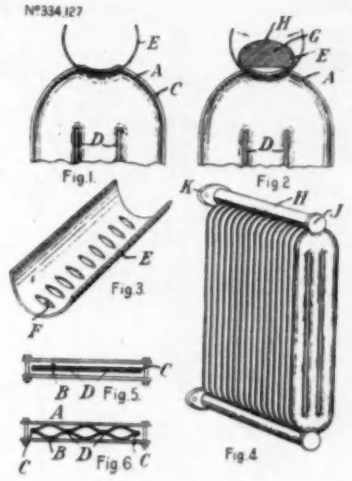
A fault in electrical apparatus is usually the result of a failure of the insulation. This may be due to defective insulation, to abnormal temperature or voltage conditions, or to other causes. Failure of the insulation is accompanied by, and may be caused by electrical disturbances, such as corona, arcing, and creepage of current along the surface of the insulation. These electrical disturbances cause vibrations, noises, and sounds, which are of different frequency from those incident to the normal operation of the apparatus, and it is the general object of the invention to provide protective means operative in response to such



vibrations and sounds. In accordance with one scheme described, a sound and vibration responsive device A is secured to the casing of an encased oil-immersed transformer, so that the device will respond to sounds and vibrations originating within and transmitted to the casing. The device A is connected in circuit with a battery B and the energising coil of a relay C. When this relay is energised, its contacts close a protective circuit, which is shown as including a battery D and a bell E. A sensitive protective device, shown as a telephone receiver F, may also be connected by a switch to the battery B and the device A. In order to prevent operation of the protective devices in response to the normal sounds and vibrations of the transformer, an electrical filter G is connected into the circuit between the device A and the protective devices.—*August* 19*th*, 1930.

334,127.—November 8th, 1929.—HEAT RADIATORS FOR TRANSFORMER COOLERS, *Associated Electrical Industries, Ltd., of Bush House, Aldwych, Westminster.*

The invention contemplates the provision of a cheap and efficient form of radiator, which is light, is entirely leak-proof, and which may be formed by welding together the joints connecting the several parts. The fluid-conducting members A are formed from flat steel plates B, having in general a rectangular form, except that they may be round at the ends. The edges of two such plates are welded together, as shown at C, and there may be intermediate lines of spot welding, as shown at D. Air under pressure is then supplied between the plates so as to deform them against fixed members of a surrounding frame. The shape of these riser members when completed is well shown in Figs. 1, 2, and 4 of the drawings. A plate member E, for forming a header section, is provided with openings F, and the plate bent into the form of a trough, as shown in Fig. 3. Such a header member is adapted to receive the end portions of a number of the riser members through the series of slots or openings F, the riser members entering through the slots to permit them to be welded to the trough-like header member from the inside. After the vertical or riser members

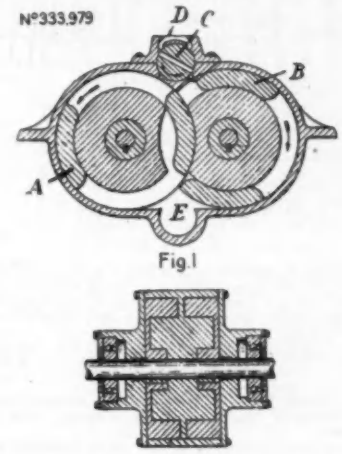


have been welded to the header members, while having the configuration shown in Figs. 1 and 3, thus forming a unitary structure, the upper curved portions of the trough forming the header member is folded over a mandrel G, and a single seam H is welded along the abutting edges of the walls of the header member. Similar header members may be attached to each end of the series of riser members, and a cap J attached to the outer end of the header member to close it. The inner ends of the header members will be provided with means K for attaching them to a transformer tank, so that oil may circulate from the transformer tank through the radiator unit and back to the transformer tank.—*August* 28*th*, 1930.

PUMPING AND BLOWING MACHINERY.

333,979. June 7th, 1929.—ROTARY PUMPS AND MOTORS, L. A. Marshall, 108, Southampton-street, Hastings Hawke's Bay, New Zealand.

In this rotary motor there are two rotors A and B, each revolving in an annular chamber. A cross section through one of the rotors is given in Fig. 2. The two rotors are geared together.

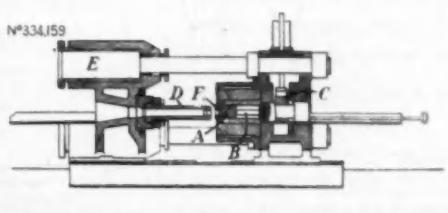


At the intersection of the two chambers there is a rotary valve C, which alternately puts the two chambers in communication with the inlet D. The sectors are so proportioned that as admission takes place, one or another of the sectors closes the annular space to form an abutment. The exhaust is shown at E. When the machine is used as a pump the valve C is not required.—*August* 28*th*, 1930.

MACHINE TOOLS AND SHOP APPLIANCES.

334,159. February 11th, 1930.—APPARATUS FOR THE MANUFACTURE OF TUBES BY THE EXTRUSION PROCESS, Hydraulik Gesellschaft mit beschränkter Haftung, 72, Mülheimerstrasse, Duisburg, Germany, and O. Schenlstedt, 64, Hundsbuschstrasse, Mülheim-Ruhr-Speldorf, Germany.

This machine is intended to produce pierced tube billets by a

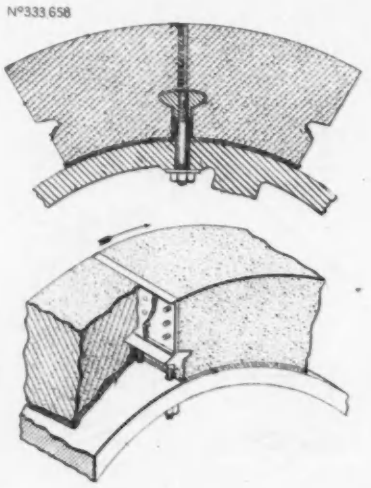


process of extrusion and punching. The billet is shown at A and is punched, hydraulically, over the mandrel B for its piercing. The mandrel is held in place after the billet has been introduced by the wedge C. The ram D is then advanced by a set of hydaulic

rams, one of which is shown at E, so that the matrix F and consequently the billet A are forced over the mandrel B.—*August 28th*, 1930.

333,658.—May 29th, 1929.—Grinding Wheels, *W. W. Triggs*, 57, *Lincoln's Inn-fields, London, W.C.* 2.

The object of this invention is to provide a stone for grinding paper pulp which will accommodate itself to great changes in temperature without fracture. The working surface of the stone is built up of segments bolted on to a drum by means of embedded bolts, as shown. The heads of these bolts are bedded on

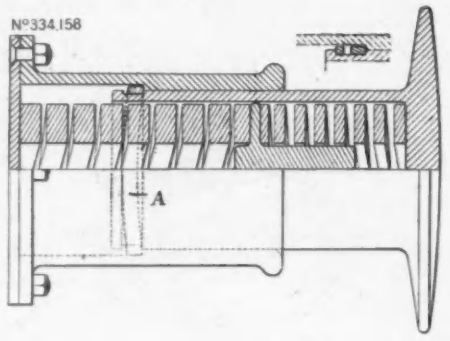


lead to give an even bearing. Between each pair of segments there is placed a thin sheet of cork, which is pierced with a large number of holes. The thickness of the cork is less than the width of the crevice. Molten lead is then poured into the crevice and also fills the perforations in the cork, so that it supports one block from the other.—*August 21st*, 1930.

TRAMWAYS AND RAILWAYS.

334,158.—February 1st, 1930.—Railway Buffers, F. J. Talbot and S. Hartley, Globe-street Steel Works, Sheffield.

The object of this invention is to minimise the blow between the buffer itself and its casing when the pressure on the main

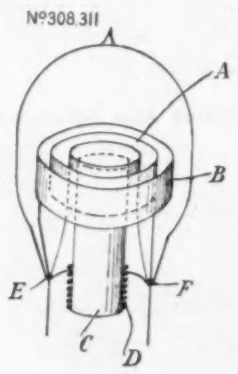


spring is suddenly released in shunting. As a consequence, the inventors make the retaining ring A, which holds the buffer in place in its casing, of a wavy form, as shown by the dotted lines, so that it has some resilience.—*August 28th*, 1930.

MISCELLANEOUS.

308,311. March 21st, 1929.—Thermelectronic Rectifier, Dr. Siegmund Loewe, of 10, Wiesenweg, Berlin-Steglitz, Germany.

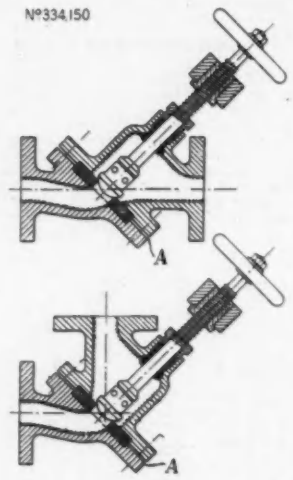
This invention relates to a new thermelectronic rectifier, which has the advantage that the cathode is heated indirectly. The invention relates to the known mode of heating the cathode by means of induction from an iron core outside the vacuum. The essential of the invention is to insert the iron core into a



re-entrant portion of the glass envelope in order to increase the induction effect. Furthermore, the cathode may be supplied with a highly emissive layer, particularly by precipitating on the surface of the cathode highly emissive metals, such as barium, strontium, calcium, or lanthanum. The cathode A consists of a cylinder opposite to which one or several anodes B are arranged. The system is sealed into a glass envelope, so that heating takes place from the outside by means of induction, the effect being increased by the iron core C, which has been inserted into a re-entrant portion of the glass envelope and has around it the winding D fed from alternating-current mains. The anode and cathode are connected by means of leads E and F, passed through the evacuated glass envelope. The surface of cathode A is made highly emissive by the precipitation of metals, such as barium, calcium, strontium, lanthanum.—*August 21st*, 1930.

334,150. December 27th, 1929.—Valves for Corrosive Fluids, P. Julien, 35, rue A. Blanqui, Marseilles, France.

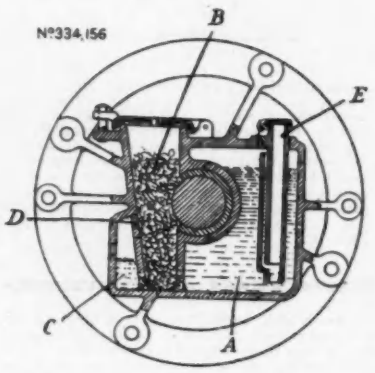
This valve is put forward as being one of which the interior surfaces are easily accessible for enamelling or metalising for the purposes of checking corrosion. It is made in two parts,



with a joint A set at an angle of 45 deg., so that it may be assembled to give a straight through or a right-angled flow. The seating, the valve proper, and its stem are made of non-corrodible metal.—*August 28th*, 1930.

334,156. January 14th, 1930.—Lubricating Devices, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.* 2.

The lubricator is shown in connection with the end shield of an electric motor. The oil is contained in an air-tight reservoir



A and is supplied to the bearing by a packing of waste B. The oil level in the chamber C is kept at the level shown by atmospheric pressure admitted at D. When the oil level in C is lowered, air bubbles through the syphon pipe E until equilibrium is restored. The pipe E also serves for filling purposes.—*August 28th*, 1930.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TO-DAY.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "The Development of the Bridge," by Mr. S. J. Crispin. 7.30 p.m.

TO-DAY TO SATURDAY, OCTOBER 11th.

Institute of Patentees (Inc.) International Exhibition of Inventions.—Central Hall, Westminster, S.W. 1. Daily, 10 a.m. to 10 p.m.

SATURDAY, OCTOBER 4th.

Institute of British Foundrymen: Lancashire Branch.—College of Technology, Sackville-street, Manchester. Presidential address by Mr. R. W. Stubbs. 4 p.m.

MONDAY, OCTOBER 6th.

Bradford Engineering Society.—Bradford Technical College. Presidential address, "Heat Engines," by Mr. W. Hiles. 7.30 p.m.

Chemical Engineering Group.—At the Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. "Recent Results in Structure Research of Colloids in Science and Industry," by Dr. E. Hauser. 8 p.m.

Institute of Metals: Scottish Local Section.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Aluminium Review. Visit of the President, Mr. Richard Seligman. 7.30 p.m.

Society of Engineers.—In the Apartments of the Geological Society, Burlington House, W. "Some Impressions of America," by Lieut.-Col. H. C. Hawkins. 6 p.m.

TUESDAY, OCTOBER 7th.

Institute of Metals: Birmingham Local Section.—In the Chamber of Commerce, New-street, Birmingham. Chairman's address, by Mr. T. G. Bamford. 7 p.m.

Institution of Automobile Engineers.—Royal Society of Arts, John-street, W.C. 2. "The Future Trend of Automobile Design," Presidential address of Sir Herbert Austin. 8 p.m.

Institution of Heating and Ventilating Engineers.—20, Hart-street, Bloomsbury, W.C. 1. "Power Plant Chimney Pollution," by Mr. G. L. Copping. 6.45 p.m.

Staffordshire Iron and Steel Institute.—Education Offices, St. James's-road, Dudley. Presidential address, by Mr. T. Hoskison. 7 p.m.

WEDNESDAY, OCTOBER 8th.

Illuminating Engineering Society.—E.L.M.A. Lighting Service Bureau, 15, Savoy-street, W.C. 2. "A Report on the Progress of Illuminating Engineering." 6.30 p.m.

Institution of Chemical Engineers.—Chemical Society, Burlington House, W. 1. "The Effect of Surface Conditions on Heat Transmission," by Mr. Saral J. Kohli. 8 p.m.

Institution of Engineers-in-Charge.—St. Bride Institute, Bride-lane, Fleet-street, E.C. 4. Presidential address, by Mr. Wm. Reavell. 7.30 p.m.

Liverpool Engineering Society.—9, The Temple, 24, Dale-street, Liverpool. Presidential address and distribution of medals and premiums. 6.30 p.m.

THURSDAY, OCTOBER 9th.

Institute of Metals: London Local Section.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. Chairman's address, by Mr. W. T. Griffiths. 7.30 p.m.

Institution of Welding Engineers.—The Engineers' Club, Albert-square, Manchester. "The Training of Operators in the Welding and Cutting Industries," by Mr. J. Ryder. 7.45 p.m.

Royal Aeronautical Society.—Royal Society of Arts, John-street, W.C. 2. "The Growth of Aviation." Opening address by the President, Mr. C. R. Fairey. 6.30 p.m.

FRIDAY, OCTOBER 10th.

Institute of Metals: Sheffield Local Section.—In the Mappin Hall, Non-ferrous Section of the Applied Science Department of the University, St. George's-square. Sixth "Sorby" Lecture, "Some Observations on the Wire Drawing Process," by Professor F. C. Thompson. 7.30 p.m.

Keighley Association of Engineers.—Queen's Hotel, Keighley. "Materials Used in Modern Engineering," by Mr. T. H. Turner. 7.30 p.m.

Manchester Association of Engineers.—At the Engineers' Club, Albert-square, Manchester. Presidential address, "Thermal Progress," by Mr. G. E. Windeler. 7.15 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "The Refining of Cane Sugar," by Mr. S. Dunlop. 7.30 p.m.

Railway Club.—57, Fetter-lane, Fleet-street, London, E.C. 4. "Notes on Time Tables and Train Running," by Mr. C. J. Allen. 7.30 p.m.

SATURDAY, OCTOBER 11th.

Institute of British Foundrymen: Lancashire Branch, Burnley Section.—Technical College, Omerod-road, Burnley. "Belgian Moulding Sands in the Ironfoundry," by Mr. F. Griffiths.

MONDAY, OCTOBER 13th.

Institute of Transport.—Institution of Electrical Engineers, Victoria Embankment, W.C. 2. Opening address by the President, the Hon. Sir Arthur Stanley. 5.30 p.m.

TUESDAY, OCTOBER 14th.

Institute of Metals: North-East Coast Local Section.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Chairman's address. Mr. C. Gresty. 7.30 p.m.

Manchester Geological and Mining Society.—Engineers' Club, Albert-square, Manchester. Annual dinner. 6.15 p.m.

WEDNESDAY, OCTOBER 15th.

Electroplaters' and Depositors' Technical Society.—Northampton Institute, Clerkenwell, E.C. 1. "Practical Difficulties in the Electro-deposition of Chromium," by J. W. Cuthbertson. 8.15 p.m.

Institution of Electrical Engineers: South Midland Centre.—Grand Hotel, Birmingham. Faraday Lecture, "The Birth of Electrical Engineering," by Professor W. Cramp. 7 p.m.

Institution of Engineering Inspection.—Rooms of the Royal Society of Arts, John-street, W.C. 2. "A Practical Application of British Standard Limits and Fits to Locomotive Construction," by Mr. E. Harle. 5.30 p.m.

Newcomen Society.—Science Museum (Demonstration Room, Ground Floor), South Kensington, S.W. 7. "Enquiry into the Origins of the Windmill," by Mr. H. P. Vowles. 5.30 p.m.

THURSDAY, OCTOBER 16th.

Institution of Mechanical Engineers.—Connaught Rooms, Great Queen-street, London. "Charter" dinner. 6.45 p.m. for 7.15 p.m.

FRIDAY, OCTOBER 17th.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, London, S.W. 1. Presidential address by Mr. L. St. L. Pendred. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "The London Automatic Telephone System," by Mr. T. H. Flowers. 7.30 p.m.

West of Scotland Iron and Steel Institute.—Royal Technical College, George-street, Glasgow. Presidential address, by Mr. Robert Hamilton. Adjourned autumn meeting. The Iron and Steel Institute. Discussion on the following papers: "What Reasons Compelled the Prague Ironworks to Introduce Thin-walled Blast-furnaces?" by Mr. J. Sarek; "Open-hearth Furnace Construction and Practice," by Mr. H. C. Wood. 7.15 p.m.

TUESDAY, OCTOBER 21st.

Society of Engineers.—Holborn Restaurant. Dinner in honour of Miss Amy Johnson's achievement in flying alone to Australia. 7 p.m.

WEDNESDAY, OCTOBER 22nd.

Liverpool Engineering Society.—9, The Temple, 24, Dale-street, Liverpool. "Notes on Surveys of Ships," by Mr. J. L. Adam. 6.30 p.m.

FRIDAY, OCTOBER 24th.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "Bitumen Emulsions, with Particular Reference to Their Use on Indian Roads," by Mr. A. P. Morris. 7.30 p.m.